DSIR RESEARCH

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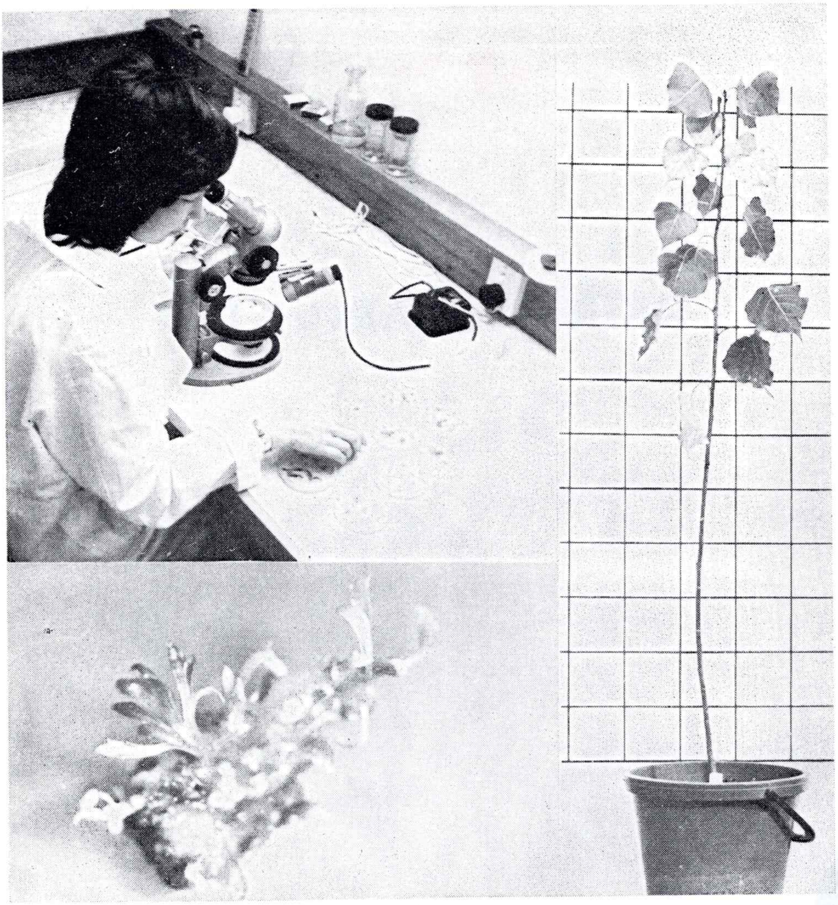
FRONT COVER —

The seed head of nodding thistle broken open to expose weevil larvae which feed on the receptacle, so cutting off the nutrient supply to the developing seeds. The weevil, *Rhinocyllus conicus,* has been introduced from Canada to help to control this noxious weed.

BACK COVER —

A Geological Survey officer collects fresh ejecta from Ngauruhoe crater after the major eruption in 1975.



Tissue culture methods being used to micropropagate rust-resistant poplars at Plant Physiology Division. The rapidly proliferating tissue can be rooted and will produce plants 1.5 metres tall within 6 months.

MAY 1978

DSIR Information Series No. 128

DSIR RESEARCH 1977

Review of organisation and activities in the
Department of Scientific and Industrial Research
and Research Associations

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unless otherwise acknowledged

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Wellington 1977

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THE DEPARTMENT

The Department of Scientific and Industrial Research, which was formed in 1926, has a first responsibility to initiate, plan, and implement scientific research calculated to promote the national interest of New Zealand. To fulfil this responsibility the Department has a staff of about 900 scientists supported by 700 science technicians and nearly 500 other staff. It spends over $28 million on its own activities and dispenses about $4 million in research grants to industrial research associations, privately endowed research bodies, certain university science projects and Government and intergovernmental scientific committees. The 23 divisions, administered from Head Office in Wellington, are grouped mainly in five research centres, with branches and substations throughout New Zealand and in the Pacific Islands and Antarctic.

DSIR is the largest scientific organisation in the country and undertakes research of a range and diversity not usually encompassed by single scientific agencies in other countries. The wide extent of the Department's work stems from an early awareness that, in a country with a relatively small population and limited economy, concentration of scientific resources of equipment and manpower is necessary for the effective application of research to the solution of practical problems.

As a consequence of the nation's dependence on agricultural production for export, the major part of the DSIR's effort has been directed to applied research for agriculture. In this, as in other areas of science, the research successes in the first fifty years of the Department's existence mean that the problems remaining require the application of increasingly specialised and complex skills and techniques for their solution. Increased basic research is now required to establish the background of fundamental knowledge on which applied research must be built. For example, the development of more productive pasture requires an understanding of plant and animal physiology; better weed, pest, and disease control can only come from the proper classification and study of plants and insects; and before pollution of the freshwater environment can be prevented or halted, a knowledge of the fundamental biological and chemical processes in lakes and rivers is required. In these as in so many other fields the Department is increasingly involved in establishing the basic data for applied research and development.

As the New Zealand economy will continue to depend for the foreseeable future on agricultural production, the Department will continue to concentrate on applied agricultural research adapted to changing economic and social conditions. Already, changing patterns in customer requirements, in the markets available to our primary produce, and in energy costs and supplies, are being countered by increased research on efficient, environmentally sound land use through the development of new crops and new varieties of traditional ones, through biological control of pests and weeds, through diversification and greater productivity from marginal land, and through greater local processing of natural products.

Greater local processing has the advantage of adding value to the product before export, but the disadvantage that control of pollution (to which processing industries can give rise) becomes a local problem. Much of the Department's work from the start has been concerned with the assessment and use of natural resources, but increasing public concern for the environment is reflected in the growing effort by DSIR required to provide the scientific data used in environmental impact reporting. Increasingly the Department's expertise in soil research, ecology, botany, and geology is being drawn on to assess the environmental impacts of proposed developments.

New Zealand is not exempt from the world-wide problem of dwindling sources of energy, and DSIR is heavily involved in the study of existing resources of coal and geothermal steam. The Department also contributes survey information for exploration for oil and natural gas reserves, and is involved in research on such alternatives as solar heating.

Water is a natural resource of prime importance, and DSIR scientists advise on the occurrence and maintenance of groundwater supplies, and the maintenance of quality. DSIR surveys have been essential in the exploitation of aggregates, ironsands, limestones, clays, and other minerals.

The Department advises manufacturers in all kinds of industry on how to overcome development, production, and management problems. It also makes available specialised equipment and expertise, particularly in testing and quality control. DSIR liaises closely with the eleven industrial research associations it helps to fund. Their work, and that of the Cawthron Institute, is described briefly towards the end of this publication.

As well as agriculture, the environment, manufacturing, energy, and minerals, the full range of activities of DSIR* encompasses forestry, transport and communications, building and construction, health, the social sciences, and scientific services such as forensic science, in fact practically all of the main areas of scientific activity defined by the National Research Advisory Council, the Government body that co-ordinates science policy and advises the Minister of Science and Technology on research priorities.

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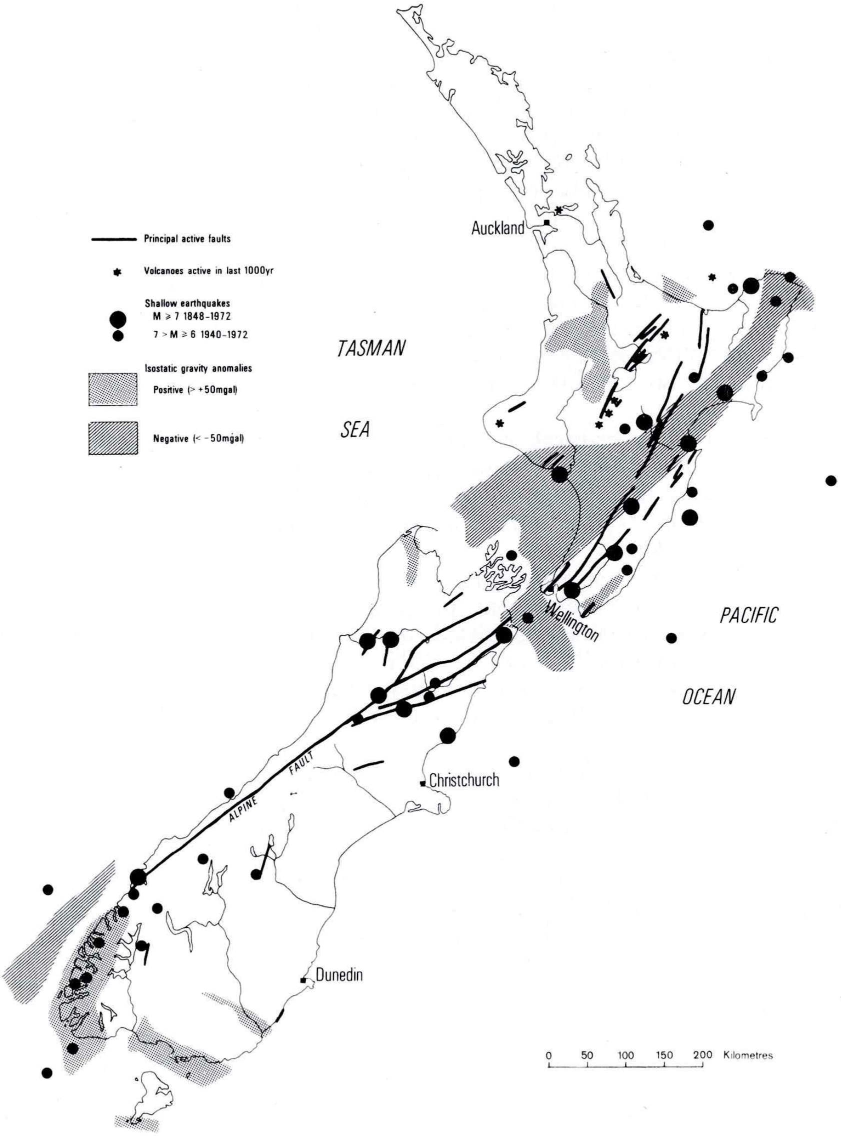
*All of the activities were reviewed in *DSIR Research 1976,* produced to commemorate DSIR's fiftieth anniversary. In this year's issue, four activities are reviewed in greater detail, namely, solid earth sciences, pasture production, human health, and scientific services. Other activities will be described in subsequent issues.



New Zealand is in an active volcanic zone, as this map shows.

RESEARCH IN FOUR MAJOR FIELDS

SOLID EARTH SCIENCES

The so-called solid earth sciences, geology and geophysics, are basic to an understanding of processes that have fashioned, and still are fashioning, the earth's surface on which we live. The origins of the processes are partly below the surface, being studied as part of geophysics, and partly above, being studied as parts of oceanographic and atmospheric sciences. Geology encompasses all these, being concerned with the results of the processes as recorded in the rocks; in addition, it embraces the range of biological sciences whose history in the rocks is fundamental to an understanding of the present natural environment.

Geology and geophysics provide the backing for a wide range of economic work, from the investigation of mineral and energy deposits to that of foundations for major engineering structures; through such work, environmental and planning problems are given consideration. In addition, studies of destructive natural processes such as earthquakes and volcanic eruptions are equally significant for the future.

New Zealand's position in the south-west Pacific is of great interest to scientists in other countries. The geological history, particularly complex for its small area, is bound up with the still-changing relative positions of Australia, Antarctica, and New Zealand, and includes features of significance on a global scale. As a consequence New Zealand scientists make important contributions to world knowledge in their fields, and the possibility of studying New Zealand problems attracts earth scientists from overseas. It is not surprising that exchange visits are common and interchange of publications is considered vital. One of the main forms of publication is the map, which is the best way of depicting information for which the area distribution is critical. Other publications range from detailed monographs to local descriptions for the general public.

Mapping

Mapping is the basis for further studies in the earth sciences. It is also a major form of communication with the general public. Geological coverage of New Zealand at a scale of 1:250 000 was complete by 1968. Complementary series of geophysical maps are being produced, which, as they disclose the nature of rocks beneath the surface, enable the geological structure to be interpreted. The gravity anomaly series, which reveals areas of rocks that are lighter or heavier than normal, shows large anomalies associated with the large scale tectonic forces affecting the country. Thicknesses of sedimentary basins (knowledge of which has many uses including oil prospecting and earthquake microzoning) can be estimated from this information. The magnetic anomaly maps show the variation in the small quantities of iron (chiefly as magnetite) in the rocks, which is often related to rock type. Thus the presence of large volcanic masses beneath sediment off the west coast of the North Island was readily deduced. The gravity and magnetic series maps, now about 90% complete, provide background knowledge which may be amplified where necessary by more detailed seismic investigations.

Geological mapping at 1:250 000 gives a good overall picture but also enables geologists to point out areas which warrant greater mapping detail. The Geological Survey in recent years has concentrated its efforts on regional mapping at a scale of 1:63 360 and more recently 1:50 000 (based on the new metric New Zealand Map Grid). The principal areas of investigation have been the Auckland region, north-west Nelson, the west coast of the South Island, and central Otago. Many of the maps published or 'in press' are in demand by mineral exploration companies. Special maps are also produced to cover particular topics, for instance maps bearing geological and mining information at 1:15 840 have been published for coalfields. Investigation of some of the 'active' faults has led to production of Late Quaternary Tectonic maps showing the deformation caused by these faults.

After field data collection, the information has to be compiled in a form that is readily comprehended. Usually the scientist prepares the map at a larger scale than is finally published, so that when it is reduced to publication scale generalisation and selection of data can be made more easily. The compilation is given to the Cartographic Section of Science Information Division for fair drawing, and arranging colour masking and final printing. In the production of scientific maps a great deal of thought is given to the way the legend is laid out and to the symbols used so that the map is as clear and informative as possible.

Photographs taken by the LANDSAT satellites, put into orbit by the U.S. National Aeronautics and Space Administration, have been made available to New Zealand scientists, mainly in DSIR, collaborating in the earth resources satellite programme. As yet they have done little to help geological mapping other than confirm previously known tectonic features, but detailed work on fracture patterns that can be seen on these photographs, and which are not apparent on the ground, may lead to a greater understanding of the earth's crust.

Rocks, time, and resources

Knowledge of the variation and distribution of different types of rock and their relationships as obtained by geological mapping and associated laboratory studies is essential for understanding the geological history of New Zealand, for many economic applications, and for the development of facilities required by the public. Maps depict in two dimensions the surface distribution of rocks. Study of the relation of rocks to contours gives some indication of the third dimension, thickness. As a basis for understanding the present and past three-dimensional distribution of rocks, geologists use many specialist techniques. Drilling, coring, and geophysical techniques are particularly important for obtaining subsurface information, both onshore and offshore.

Aerial view of the south coast of Fiordland. This rugged area is being mapped by officers of the Geological Survey District Office, Dunedin.

The primary step is the careful measurement, description, and sampling of rocks. However, the key to understanding the relationship of rock units is the use of the fourth dimension—time. Determination of time is essential for the dating of rocks, for documenting the lateral and vertical changes of rock types and their depositional environment, to demonstrate the presence of time gaps, and to establish the sequence of geological events, such as changes of sea level, uplift, mountain-building, and climate.

Time is determined by three main methods: by the study of fossils, by radiometric dating of suitable rocks, and by measuring the sequence of magnetic reversals in rocks (paleomagnetic stratigraphy).

Fossils, the classical means for determining time, remain the most important. Paleontologists at the Geological Survey, through detailed studies of morphology, evolution, and classification of fossils, including computer analysis, are constantly refining knowledge of the subdivision and age of rock sequences. This research is the basis for establishing, for the first time for some intervals, detailed macrofossil and microfossil zonations. Major recent results include the discovery of a latest Precambrian microfossil zone, establishment of a detailed graptolite zonation in north-west Nelson which is closely similar to that in eastern Australia, recognition of the entry of angiosperm pollen earlier in the fossil record, and the discovery by amateur collectors of the first possible terrestrial dinosaurs.

Radiometric studies, including radiocarbon dating of younger rocks (undertaken in conjunction with Institute of Nuclear Sciences) are progressing in many parts of New Zealand. Each date contributes to the geological history of an area, often leading to major revisions; some have stimulated new ideas on events during the Rangitata Orogeny, a major period of earth movements 160 to 100 million years ago. Paleomagnetic stratigraphy is being developed in rocks of the last 15 million years, where intervals of normal and reversed polarity are being related to the sequence of fossil species and assemblages.

Assessment of geological history is particularly difficult in a geologically active country like New Zealand, where rapid lateral changes of rock types and a complex history of geological events are characteristic. Adequate information and accurate assessment of the rocks of the last 100 million years are crucial for evaluating our resources of coal, gas and petroleum, for planning, and for understanding events such as earthquakes, volcanic eruptions, and changes of sea level. The need for energy resources, which requires integration of earth science research in many sub-disciplines, is the reason for the Geological Survey's initiation of a major study of these rocks. Evaluation of existing data, and the collection and use of new data, are being facilitated by the adoption of standardised methods of recording and presenting geological information. Basic research, including mapping and the determination of time, is fundamental to the success of this programme.

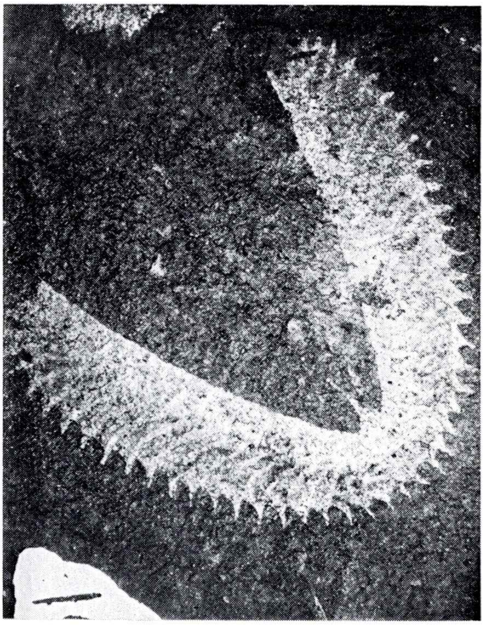
The older sedimentary rocks of New Zealand

In recent years an increasing amount of work has been carried out on the older sedimentary rocks of New Zealand, particularly in the South Island. These rocks are predominantly hard grey sandstones and siltstones, often monotonous in aspect and lithology over considerable areas, but of great interest in the tectonic history and evolution of New Zealand. Moreover, they are of considerable importance, not only as the host rocks for a few mineral deposits, but also because they include the most useful source of road metal and concrete aggregate in the country.

Over parts of the west coast of the South Island the Greenland and Waiuta Groups have long attracted interest because their stratigraphic relations to other formations indicate that they are very old, and until a few years ago they were confidently believed to be Precambrian. However, in 1974 a few fossils (graptolites) discovered in siltstone near Reefton showed that the rocks are Ordovician, and at about the same time radiometric dating of whole-rock samples at the Institute of Nuclear Sciences confirmed the paleontological age at around 495 million years. Recent field and sedimentological studies by the Geological Survey, in co-operation with staff of the Geology Department, Canterbury University, have shown that both groups of rocks are essentially similar, and it has been proposed that the name Waiuta Group be dropped.

The other main series of sedimentary rocks to have received close study over the past few years was early named the Torlesse, after the Torlesse Range in Canterbury, where they are typically exposed. The

Graptolites are an extinct group of minute colonial animals. In the specimen illustrated *(Isograptus victoriae maximodivergens* from the Lower Ordovician rocks, 470 million years old, in north-west Nelson), the now flattened individual tubes that housed the polyp-like animals can be clearly seen, curving away from the two branches of the colony. The colonies floated in the sea, as part of the Palaeozoic plankton, and were widely distributed. Because of this, and of their rapid evolution, they are extremely useful fossils for dating and correlating rocks. Three poorly preserved fragmentary specimens found in rocks of the Greenland Group were sufficient to accurately date the rocks as basal Ordovician (about 490 million years old).



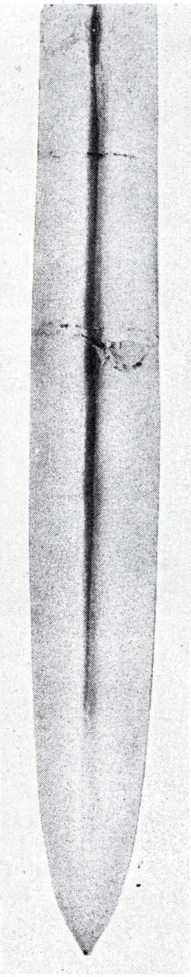
rocks—mainly sandstone and mudstone—make up a large area of the South Island east of the main divide and several of the axial ranges of the North Island. Like the Greenland Group the rocks are hard and partly recrystallised, and they show little change in colour or general texture and appearance over wide areas. Although fossils are difficult to find and often fragmentary, close searching in many districts of both islands has confirmed a considerable number of fossil localities and has enabled the age of the rocks to be fixed with reasonable confidence as Triassic or Jurassic (about 150 to 220 million years ago). Because of the severe crushing and distortion of the sediments after their deposition and compaction, the rocks have proved difficult to map and subdivide in the field. However, in recent years mapping in North Canterbury has proved that "marker" beds, comprising thin layers of lavas, poured out contemporaneously into the original sediments can be followed for considerable distances.

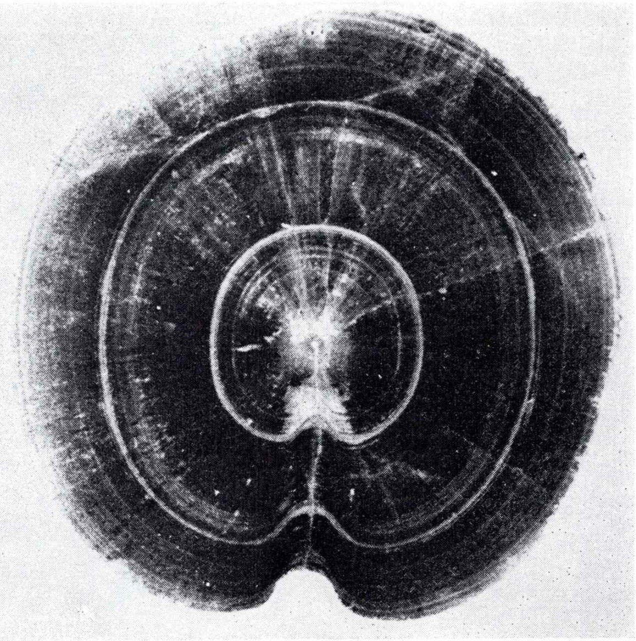
In the same region, zones of chaotically mixed rocks, the result of slumping of consolidated or partly consolidated sediments, have been discovered. Detailed work on the mineral composition of the sandstones and on pebbles from the rare interbedded conglomerates, is being carried out by several geologists in an effort to determine the source of the detritus making up the sediments.

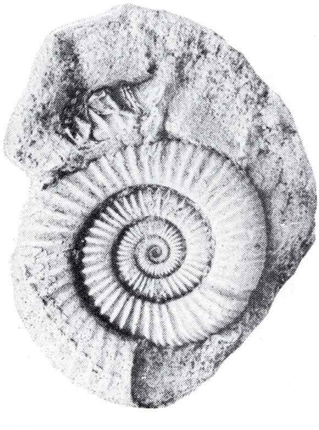
The younger sedimentary rocks of New Zealand

Cretaceous and Tertiary strata are of particular importance in New Zealand as the sources of coal, oil, and gas.

Basins of sedimentary accumulation have been studied by geologists



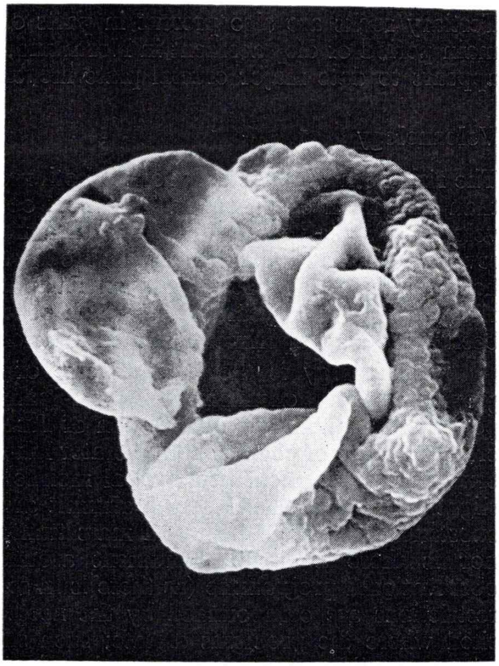




Belemnites are bullet-shaped shelly tail bones from extinct squids. The one pictured on the left is 11 cm long and came from rocks 150 million years old. Oxygen isotope analysis of these and other fossils has provided a record of the temperatures of ancient seas and indications of past climatic changes. Lime containing the oxygen isotopes was extracted from the sea water by the belemnite and used to build its shell. During its lifetime the belemnite gradually added shell material in layers so that a cross-section shows a series of concentric growth layers like tree rings. The oxygen isotope content of each depends on the temperature of the sea water at the time it formed. Therefore detailed analysis, layer by layer, provides a record of sea water temperatures. The right-hand photo is a polished section across a belemnite 1 cm wide, showing the concentric growth layers.

The age of the vast areas of "greywackes" or Torlesse Super-group rocks that occur widely in New Zealand has been difficult to determine. However, the discovery of diagnostic fossils is providing geologists with a better understanding of age relationships. For example, discovery of this fossil ammonite (an extinct sea mollusc related to the modern pearly nautilus), *Idoceras speighti,* from the Karetu River, near White Rock, North Canterbury, enabled geologists to assign an age of 150 million years to the surrounding rocks. The specimen is 5 cm across.

A scanning electron photomicrograph of fossil pollen of *Microcachryidites parvus* Couper, similar to saccate pollen of *Microcachrys tetragona* Hooker, a gymnosperm found growing today only in the mountains of Tasmania. This extinct pollen type first appeared in New Zealand in the Lower Miocene (20 million years ago) and died out in the Lower Pleistocene about 2 million years ago. It is very common in the Upper Tertiary coal measures of Southland and Otago and is one of many species used to determine the paleoenvironment and age of these coals and to distinguish between them and the older coals in the same area.



from Geological Survey, universities, and oil companies and much information about them is available in geological bulletins, papers, and unpublished reports. A ten-year Cretaceous–Cenozoic Basinal Study Project by the Geological Survey, with co-operation from universities, is under way to review this information and to undertake detailed examination of rock sequences so as to tie them all in to a regional study by mapping a number of synchronous levels well defined by fossils.

In Late Miocene to Quaternary rocks, the increasing number of both onshore and offshore sedimentary sequences in which paleomagnetic reversals and oxygen isotope changes have been worked out ,and also the availability of many radiometrically determined ages (e.g. by potassium–argon dating and fission track counting methods) has opened up new possibilities for relating the geological record of New Zealand, especially over the past five million years, to changes in the Polar Ice caps, world wide changes of sea level, and changes in climate leading up to the present day.

In particular, in recent years mapping of the Cretaceous in the east coast North Island, especially Raukumara Peninsula, has been carried on for several years by Geological Survey in co-operation with the University of Auckland, and considerable advances have been made in understanding the rock succession and structure of the area.

Drilling of deep petroleum exploration wells and field mapping in Northland have shown that extensive areas of rocks of Late Cretaceous to Oligocene age of up to 2.5 km thickness have been displaced into their present position where they now overlie younger rocks. Displaced

Tertiary rocks are also present in parts of Raukumara Peninsula. The main period of displacement in Northland, around Late Oligocene time, appears to date major crustal plate movements in the South Pacific.

Volcanology

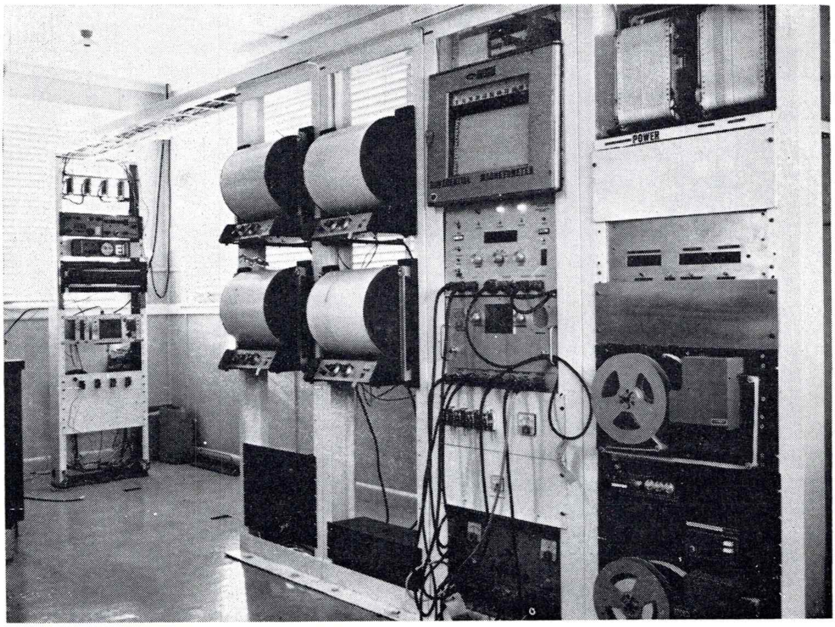
The risk from volcanic eruptions is both more localised and less frequent than that from earthquakes. The most obvious and frequent source of volcanic risk is that from Ruapehu, a mildly active volcano, because several thousand skiers throng its slopes throughout the winter. DSIR has maintained an observatory on Ruapehu, near the Chateau Tongariro, for nearly 20 years, from which observations of the volcano have been made and experiments related to its eruptive behaviour carried out.

Volcanology is the most diverse of the earth sciences; geology, geophysics, and chemistry are principally involved. There has been periodic or continuous observation of Ruapehu, and records of historic eruptions, and of changes to the crater lake water and lake level between eruptions, supplement geophysical monitoring. Periodic observations of slight changes of shape of the summit area are made geodetically. No substantial theory of heat and mass transfer in volcanic regions exists; nor is there a single instrument around which to build a simple observational programme (as there is in seismology for example). These restrictions are compounded by the necessity for the equipment to be sited where the problems dictate; such sites can be very rugged, hard of access, difficult of communication. Moreover there is ultimately the possibility of the instrumentation being destroyed by the very activity it is recording. The use of helicopters for transport, radio-telemetry for communication, solar cells for battery-charging, and magnetic or paper-tape recording techniques are examples of modern techniques which are helping to ease the logistic problems. A recent grant from the Golden Kiwi Lottery, Scientific Distribution Committee has enabled the instrumentation on the mountain to be upgraded, and at present seismographs, magnetometers, a barograph, a tiltmeter, and a lake temperature-measuring device are being operated. A long series of observations correlated with eruptions will be necessary to assess whether the present style of eruption of Ruapehu can be predicted.

Cataclysmic eruptions at intervals of several hundred to thousands of years have occurred elsewhere throughout the Central Volcanic Region. The long intervals between such events make investigation difficult. A target area must be defined, presumably where magma is beginning to accumulate in the earth's crust. A search for such possible magma pockets is in progress. It is assumed that catastrophic ash or ignimbrite eruptions would be preceded for some time by unusual activity such as earthquakes or earth deformation. Characteristic earthquake "swarms" occur at intervals of years in the Central Volcanic Region (e.g., near Taupo in 1964–65 summer), but no sequential volcanic activity has ever been observed after these. Instrumental earth deformation studies have recently started in the region.

Earthquakes and earth deformation

Sufficient tremors are felt by most New Zealanders for them to be aware



Interior of Geophysics Division's Volcanological Observatory at Whakapapa Village, Tongariro National Park. This complex of instruments includes 3 seismometers, 4 magnetometers, and means of recording the temperature of Crater Lake, tilt, atmospheric waves, and earth currents.

Some of the disruptive effects of earthquakes could be averted if a reliable means of predicting their occurrence could be found. The radon content of the water in this well is regularly measured as part of Geophysics Division's research programme on earthquake prediction.

of the potential risk from earthquakes, though it is nearly 50 years since the last earthquake which caused major damage and loss of lives. The positions of all earthquakes which are felt and many which are only recorded instrumentally are listed in the annual Seismological Reports of Geophysics Division. These listings, together with the details of a number of large shocks derived from human observations before instruments were available, altogether numbering over 14 000, have been stored on magnetic tape. Engineers and town planners often ask for lists of earthquakes which have occurred in particular geographic areas of New Zealand, near certain towns or planned construction sites, or on other criteria.

Though our knowledge of where and when earthquakes have happened in the recent past is excellent, the problem of determining where and when major shocks will occur in the future is now also preoccupying the geophysicist and geologist. We have for many years been able to say that they will occur within a broad band about 200 km wide stretching from East Cape to Fiordland. However, recent theoretical, experimental, and observational work has led earth scientists to the belief that it is possible to detect changes in the ground in the vicinity of an earthquake well before the shock occurs. Investigations of these changes by Geophysics Division include variations in the velocity of seismic waves in the ground and abnormal emission of radon from groundwater. Physics and Engineering Laboratory is instrumentally recording earth strain at a number of localities, and Geological Survey is recording minute but detectable changes in shape of the earth's surface. These changes in shape are being studied by extremely accurate measurements of angles, distances, and heights, between markers especially installed in regions where most earthquakes are to be expected. The rates are compared with those inferred from the geological record, which also serves to delimit the more significant areas where ground deformation might disrupt man-made structures. Further comparison is made with the inferences from differences between successive Department of Lands and Survey triangulations, being analysed by Geophysics Division.

Magnetic observatories

Among the oldest activities of DSIR are those at the magnetic observatories at Amberley, near Christchurch, and Apia in Western Samoa. The establishment of such observatories throughout the world during the nineteenth century was necessary for compilation of navigation charts based on the magnetic compass. Surprisingly, such magnetic charts are still required by shipping and aviation, in spite of the development of new methods of navigation. Additional importance has been given to the control function of the observatory by the use of magnetic surveys for minerals and the unravelling of geological structure, particularly beneath the oceans, as well as research in the upper atmosphere, where transient geomagnetic effects are caused by disturbances in the electrified atmosphere. A third magnetic observatory was established at Scott Base in 1957. Because of urban development, the Amberley observatory will be moved to Lauder, central Otago, during 1977.

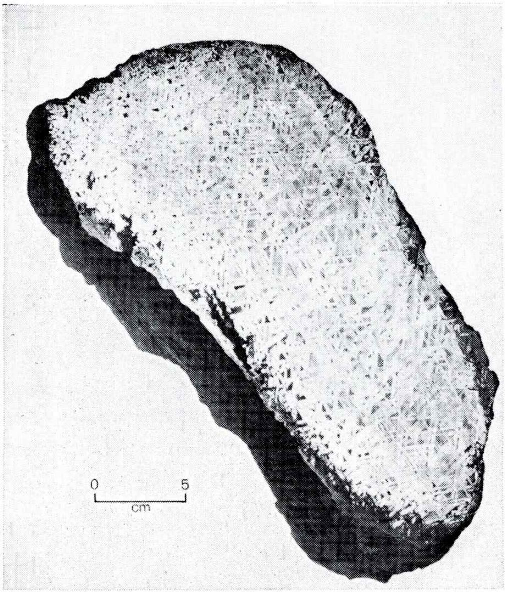
Precise triangulation surveying, undertaken by Earth Deformation Studies section of N.Z. Geological Survey, is designed to determine ground movement across the Wellington Fault.

Environmental geology

Increasing interest in the natural environment in recent years has stimulated public concern over the effects of major developments. Government procedures for environmental impact reporting, assessment, and auditing have greatly increased the activity of the Geological Survey in this field. Officers are frequently called on for information on the geological environment, and for advice on the likely consequences of various types of development. The Geological Survey has in recent years contributed much practical information and interpretative comment for the compilation of environmental impact reports required both by other Government departments and private interests. The effects of proposed drainage and water supply schemes, hydro-electric power stations, irrigation schemes, reclamations, mining operations, and other human works on the environment are greatly dependent on the geological make-up of the country. The influence of these proposals on the environment is pointed out, and, where possible, alternative suggestions causing less disruption or damage are made.

The Commission for the Environment, which is responsible for auditing environmental impact reports and making recommendations to the Government, frequently calls on DSIR to comment on environmental aspects of such proposals. Geological hazards (floods, earthquake damage, volcanic risk, waste of mineral resources, possibilities of destructive land movement such as landslides, and loss of scientifically unique or rare features) are pointed out as well as the general suitability of the geology of the region affected.

This work is closely allied to the longer-established practice of official geological comment on district and regional planning schemes. Where appropriate, suggestions are made for the reservation of important areas and their preservation for educational, scientific or recreational purposes. In addition contributions are made to regional resource surveys and to land inventory mapping co-ordinated by the Department of Lands and Survey.



Polished and etched surface of the Dunganville meteorite, an extremely coarse iron meteorite found near Greymouth in January 1976. It is the largest found in New Zealand and weighed approximately 54 kg before being cut. Portions of it are being studied by petrologists at Geological Survey.

Relation of earth science to other science budget activities

Earth science is a part of the National Research Advisory Council's "Natural Environment" activity. Much of the work within that activity involves what most people understand as being included in the term "environmental studies". Such work includes surveys and laboratory research into the distribution of animals, plants, and inorganic materials, and the effects on these of actual and proposed developments. DSIR's work in the solid earth sciences, that has been described above, is a major part of this activity.

In addition, however, studies in solid earth sciences provide essential basic information that is used by a wide variety of people and organisations for a multitude of purposes—geological and geophysical publications, reports and maps are used by mineral explorers, by civil engineers in various development projects, ranging from hydro-electric dams to airport construction, by town and country planners, by manufacturers seeking local raw material substitutes for imported items, and by amateur scientists, etc. Thus they have relevance to the fields of mineral production and processing (see major article in *DSIR Research 1975*), building and construction (*DSIR Research 1973*), and manufacturing (*DSIR Research 1975*). Earth science work in Antarctica was reviewed in *DSIR Research 1972*, and studies of the seafloor were described in *DSIR Research 1973*.

PASTURE PRODUCTION

During the 30s and 40s, the development of improved pasture species and the elucidation of the salient features of the soil–plant–animal complex in grassland farming lifted production by our pastoral-based industries very markedly. The philosophies developed at this time were the basis for further expansion during the 50s and 60s. Contributing factors were the better use of hill country through aerial topdressing, the development of pumice country and other regions such as Te Anau, and the benefits from an intensified plant breeding programme.

Since 1968, production of pastoral products has faltered because of several drought years, severe pasture losses from insect damage after use of organochlorine insecticides was banned, and intangible factors resulting from loss of farmer confidence because of adverse pricing structures and social difficulties. There has, however, been an encouraging upswing over the last two seasons.

Within the foreseeable future, pastoral-based products will continue to predominate in our exports. It is essential that this vital sector be backed up by high-quality research in pasture production, since there will be a need for improved technology to give maximum production with minimum inputs of labour, energy, fertilisers, and other materials.

This review summarises the main features of the DSIR contribution to the national programme; there are many cross-links to the substantial programmes of the Ministry of Agriculture and Fisheries, the universities, and the private sector. Grasslands, Entomology, Applied Biochemistry, Plant Physiology, and Plant Diseases Divisions and Soil Bureau undertake the main programmes, with several other Divisions also contributing in a lesser capacity.

PLANT BREEDING

Completed breeding programmes

Over the last 40 years, Grasslands Division has mounted programmes to provide improved well tested cultivars, sufficiently stable and distinct for certification in New Zealand and overseas. As a result of completed breeding programmes 15 cultivars have so far been released:

'Grasslands Ruanui' ryegrass, a true perennial with widespread seasonal production.

'Grasslands Nui' ryegrass, a true perennial with the same attributes as 'Ruanui', but with superior production in all seasons.

'Grasslands Ariki', a perennial hybrid from crosses between perennial and short-rotation ryegrass, with better winter production than 'Ruanui'.

'Grasslands Manawa', a short-rotation (3–4 years) hybrid between perennial and Italian ryegrass, combining some of the characters of both parents, but in appearance and palatability more like Italian.

'Grasslands Paroa', an Italian annual ryegrass, capable of producing appreciably more than perennials during the winter and early spring.

'Grasslands Tama' ryegrass, a tetraploid derived from Westerwolds, the extreme annual form of Italian ryegrass.

'Grasslands Apanui' cocksfoot, bred from N.Z. material to provide vigorous summer–autumn growth in dairy pastures, also used as a pasture dominant where rainfall and soil fertility are too low for vigorous ryegrass growth.

'Grasslands Kahu' timothy, bred from Welsh cultivars as a late-heading pasture type.

'Grasslands Matua' prairie grass, which has good winter growth, but is also productive in other seasons if laxly grazed and given adequate fertiliser.

'Grasslands Huia' white clover, bred from the best ecotypes which have developed in New Zealand, and adapted to a wide range of environments and farming systems.

'Grasslands Pitau' white clover, bred by hybridisation of New Zealand white clover with a winter-active Spanish ecotype, and better adapted to North Island conditions than to the South Island.

'Grasslands Turoa' red clover, a late flowering summer-active cultivar derived from New Zealand Montgomery red clover.

'Grasslands Hamua' red clover, an early flowering cultivar providing a reasonably high quantity of dry matter during summer months.

'Grasslands Pawera' red clover, a late flowering tetraploid derived from Turoa and other late flowering diploid cultivars.

'Grasslands Maku' lotus, a tetraploid *Lotus pedunculatus,* suitable for low-fertility moist soils.

Several of these cultivars have been more adequately described in *New Zealand Certified Herbage Seed* (N.Z. Department of Agriculture 1969).

Each cultivar requires that the breeders must maintain the parent plants safely for several decades, and that, at each 'nucleus isolation', they be brought into a pollen-proof isolation house sufficiently replicated and randomised to provide a stable seed harvest for further increase.

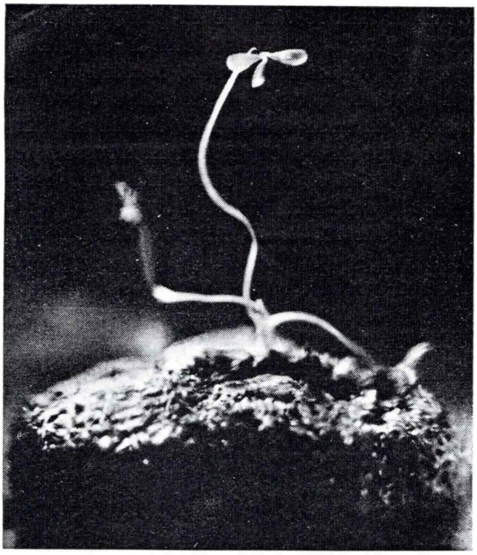
A further 11 breeding programmes have been completed recently, and the resulting "pipeline" cultivars are on widespread trial to decide their eventual release as named cultivars. They include two ryegrasses, two cocksfoots, two lotuses, and one each of phalaris, paspalum, tall fescue, white clover, and serradella. Some of these are improvements over existing cultivars, but others are intended to fill new niches in New Zealand farming.

Current breeding programmes

The main trends in present plant breeding programmes are towards producing plants for more specialised regions and applications, incorporating insect resistance or tolerance, increasing phosphate utilisation and the root system of white clover, and obtaining interspecific and intergeneric hybrids.

Specialised regions that are unsuited (e.g. climatically) to the existing cultivars include moist hill country, dryland, high country, and Southland and Northland. At Grasslands' hill country station at Ballantrae near Woodville, projects involve a grass and a legume (perennial ryegrass, white clover) that are regarded as a more desirable final pasture, but perhaps poorly adapted to the current fertility levels and management systems of moist hill farms; and a grass and legume

Gracefully sinuous, this seedling, growing in a 'cake' of semi-sterile peat, is a hybrid between Caucasian and Alsike clovers *(Trifolium ambiguum* x *T. hybridum).* It was produced by means of embryo culture, a technique used to overcome some of the difficulties of making viable interspecific crosses.



(browntop, lotus) that are considered better adapted to the present, but perhaps offering less long-term potential. For all except lotus, most of the experimental material being screened has been collected from hill farms from Taranaki to Poverty Bay, and Southland.

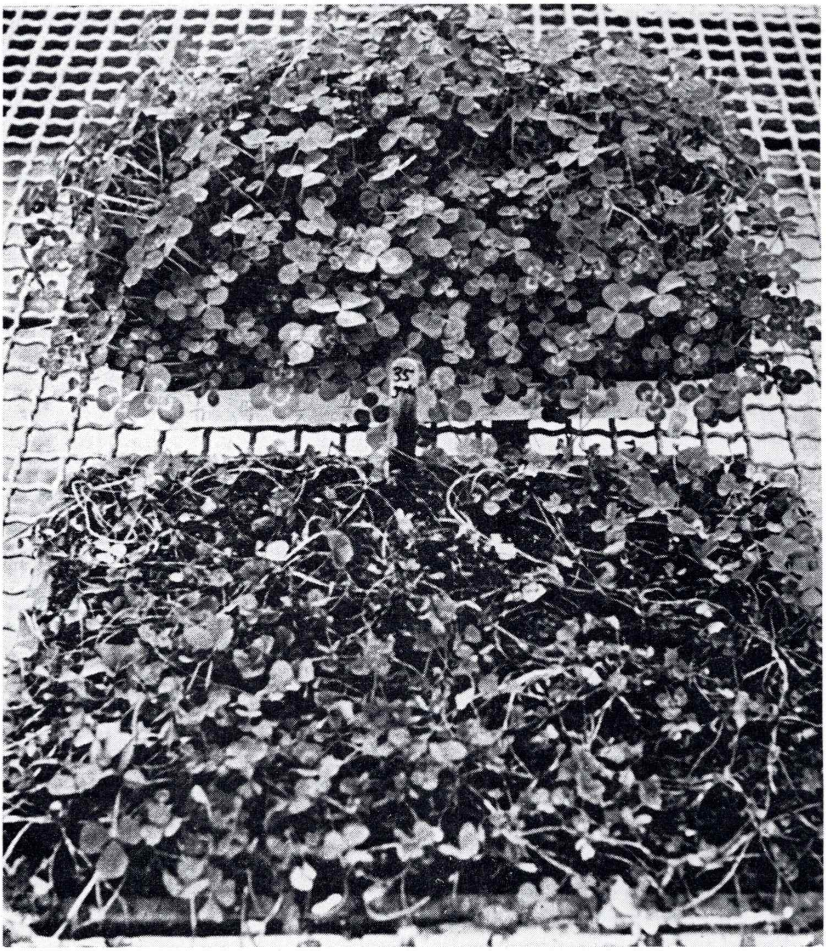
For dryland species, screening projects at Grasslands' station at Kirwee (Canterbury), Porangahou (Hawke's Bay), and Flock House, include ryegrass, perennial and annual clovers, and lotus. High country sites in the Mackenzie Basin are being used to screen a wide range of "new" grasses and legumes. For Southland, the main aim is to breed more suitable cultivars of the familiar perennial ryegrass and white clovers. In Northland, however, a wide range of subtropical grasses are also being studied. In such species plenty of summer forage is usually produced, but quality is often low and compatibility with cool-season temperate species poor. The most promising of these species are also being screened at Palmerston North for useful variation in cold-tolerance, as well as an attempt to fill the summer feed shortage in such regions as the Manawatu.

In work on insect resistance, highest priority has been given to screening white clover for resistance to grass grub. Over 200 populations of white clover chosen from a wide geographical background have been sown in microplots in a Ministry of Agriculture and Fisheries research area at Takapau known to have high levels of grass grub infestation. Measurements are being taken in both plant growth and insect population levels.

Another possible source of resistant genetic material is highly infested established pasture. The most vigorous plants from such sites are being tested to show if their vigour was due to some environmental factor or to genetic resistance.

Attempts are being made to breed a white clover cultivar that can establish and give reasonable yields on soils with low available phosphorus. Several hundred white clover genotypes are being screened at high and low levels of phosphorus in the glasshouse. In addition the root systems of white clover cultivars grown in the field and in the glasshouse are now being studied. It is hoped that selection will lead to an agronomically useful white clover with a stronger and longer root system than is commonly found in this species. Selection for particular root types may be useful in development of cultivars not only efficient in phosphorus and other nutrient use, but also drought resistant and more persistent.

Bloat in cattle, mainly those grazing white clover and red clover, is a major problem. Because the presence of condensed tannins in the foliage appears to prevent bloat formation in the rumen, several hundred populations of each species have been tested for tannins. They have been found only as traces in the flowers or leaflet axils, but chemical



One of the major pasture pests in New Zealand, warranting the greatest research programme ever mounted to solve an agricultural problem here, is the grass grub. The white clover plants in the nearer tray show the effects of damage by grass grubs.

mutagens are being used in an attempt to "switch on" tannin production in leaves. Also, breeding productivity into lesser-known legumes such as lotus, sainfoin, and crown vetch, which already contain tannins, is being attempted. Collections are being screened for productivity under regular grazing in mixed swards at Palmerston North.

In breeding programmes to produce hybrid cultivars between *Lotus* species, and from *Lolium* x *Festuca* crosses, the main problems are in achieving seed fertility or reasonable uniformity. In breeding commercial interspecific hybrids in cocksfoot and ryegrass, the main problems so far appear to be, not in achieving extra productivity through hybrid vigour, but in assuring a ready supply of cheap seed.

For New Zealand lawns, parks, and sportsfields, because the seed supply is either from overseas or from New Zealand pastures—in each case not entirely suitable material—cultivars of browntop, chewings fescue, and perennial ryegrass are being bred.

There is also collaboration with Crop Research Division in breeding lucerne cultivars more suitable for the North Island, with its propensity for greater cool-season growth and greater insect/disease damage.

PASTURE ECOLOGY

The production of high levels of feed for livestock from pastures in different regions of New Zealand at all seasons of the year, and its efficient utilisation, is the ultimate objective of most of the pastoral research projects of Grasslands Division. These production levels can be markedly altered by grazing frequencies and intensities, by stocking rate, the duration of the grazing period, damage caused to pasture plants by treading in both wet and dry conditions, and many other factors as they interact with the different species in pasture. A considerable amount of work carried out in these fields has culminated in the development of management systems that have markedly raised pasture production levels. Some systems have enabled production levels in excess of 1000 kg of meat per hectare to be achieved in farm scale studies, whereas others have achieved carrying capacities in excess of 25 ewes per hectare.

Pasture management such as this has led to the widespread occurrence of situations where, at times, temperature, moisture, and mineral nutrition are near optimal for pasture production; when this occurs, further gains in plant productivity can be obtained by influencing the light relations of pastures especially by the frequency and intensity of defoliation. Important management principles have emerged from studies in which defoliation has been controlled to obtain the most efficient interception of incident light as the energy source for photosynthesis. Defoliation affects not only the amount of leaf area available to intercept light, but also the availability of reserves for regrowth and the numbers of growing points.

Variation of plant species morphology and interactions with temperature, water availability, and nutrients influence the relative roles of leaf area, reserves, and growing points in pasture regrowth after defoliation. The different responses by different pasture species are being defined and used to provide recommendations to optimise growth and persistence.

Latitudinal, altitudinal, and seasonal variation of temperature in New Zealand is such that a range of species and cultivars is required to provide the optimal production response to temperature over the whole country. With knowledge of the physiological basis of temperature response it has been possible to make informed recommendations for the introduction of plant material from climatic regions different from those of S.W. Europe which provided many of the adventive species in New Zealand, to recommend selection criteria to breed cultivars with improved out-of-season production or greater tolerance to climatic extremes, and to formulate mixtures of species which can most fully exploit seasonal differences of temperature.

Much more comprehensive understanding of the separate effects of light, temperature, moisture, and nutrients, and their interactions on the growth of pasture plants has been made possible by the availability of controlled climate and computer facilities in recent years. One series of experiments is being developed within the framework of a detailed computerised model of the growth of ryegrass using data from climate room control of light and temperature and field experiments involving plant competition and defoliation.

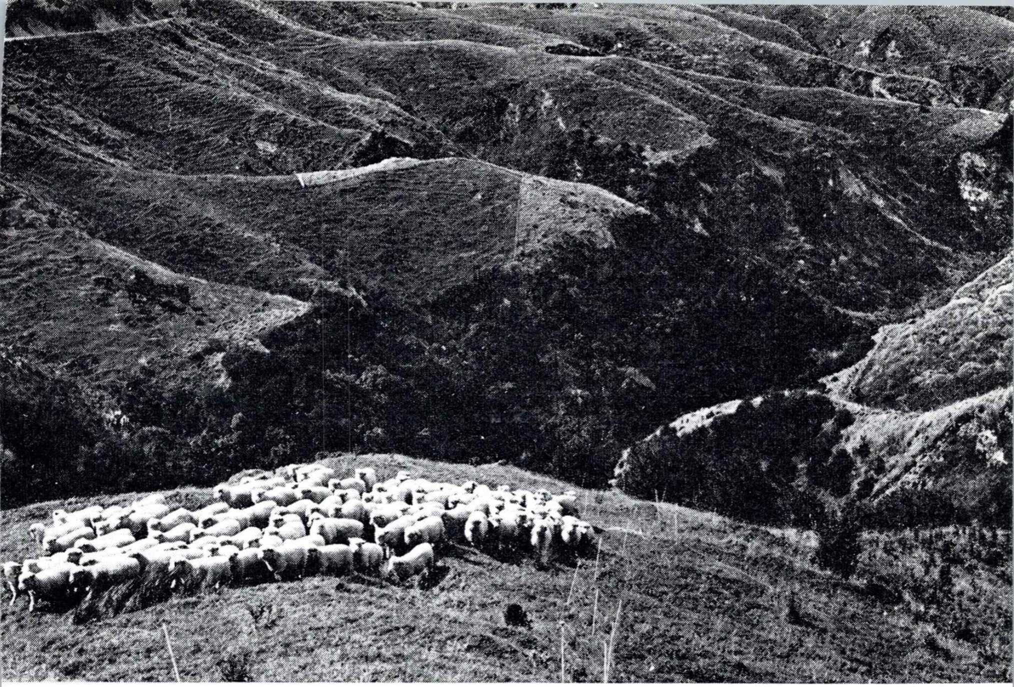
Warm temperate (Northland) pastures

A large proportion of Northland pastures is established on soils degraded by intense weathering and leaching. Drainage is often impeded, and natural fertility low. Erratic rainfall patterns cause unpredictable changes in pasture growth and quality, so that stocking policies are generally conservative and there are problems in maintaining good pasture composition and vigour.

Intensification depends firstly on devising fertiliser policies appropriate for the complex of soils and secondly on matching stock feed supply and demand more efficiently. Research has indicated that systems of pasture management in which rotational grazing is incorporated can achieve carrying capacities in excess of 22 ewes per hectare. More recent research has shown that split lambing in spring or lambing a proportion of the ewe flock in autumn improves management flexibility and reduces stress on both animal and pasture during critical periods in early spring and mid-summer. Other potential benefits include a reduction in the need for expensive feed conservation and a better spread of stock supply for freezing works.

Legume performance. — Lotus species are better adapted than clovers to the more acid, less fertile soil types, and are being considered as an alternative sown legume for Northland hill country. The potential value of lotus depends largely on the economics of fertilising, liming, and subdividing hill country. Some lotus seed is being included in mixtures for sowing newly developed hill pastures, and it is also sown with cocksfoot for stock grazing beneath pine forests.

Tropical grasses. — Much of the Auckland province is warm enough to allow a number of grasses of tropical origin to establish in the pastures. The most valued of these is paspalum, which produces well during mid-summer when conditions are less favourable for temperate grasses. The highest production has been obtained where paspalum was associated with ryegrass and white clover, and researchers are investigat-



Increased emphasis is being given to problems of hill country farming. This view is over Grasslands Division's hill country research area in the Lower Ruahine Ranges.

ing management variations so that pasture composition can be adequately controlled.

In recent years paspalum has declined in abundance throughout Northland, probably because of the ravages of black beetle and overgrazing. This has increased the summer feed problem, but research on other tropical species from the United States, Africa, and Australia has produced no obvious candidates to replace paspalum for intensive management systems.

Kikuyu grass is another tropical species widely distributed in Northland. Because of its aggressive vegetative spread it is far less acceptable than paspalum, and control is difficult and expensive (if not impracticable). Experiments in which annual ryegrasses and prairie grass have been oversown into Kikuyu-dominant pasture have increased herbage production up to 230% over the critical late winter/early spring period. When grazed by cattle Kikuyu tends to build up a stolon mat, with a result that other species disappear and feed quality falls off. However, intensive grazing by sheep can produce a well balanced composition and satisfactory animal production.

Hill country pastures

In the past five years there has been a marked resurgence in the direct involvement of Grasslands Division in hill country pasture research. Activity has been focused on moist North Island hill country as typified by Ballantrae, the Division's regional station located in the foothills of the southern Ruahine Range. More recently a programme has also been initiated in the dry North Canterbury hill country at Hunua.

A broad-based survey of pasture composition across different classes of farmland in the Manawatu in the late 1960s established the marked inferiority of local hill pastures. The composition had not altered greatly from the browntop-dominant pastures mapped over most of the southern North Island hill country by Madden in 1940. Current studies concern improvement of poor hill pasture and the influence of various factors including management, species composition, pests, and environment on productivity.

Pasture establishment. — The hill country farmer is largely restricted to oversowing as a means of introducing new pasture species. After aerial oversowing of legumes into poor pasture at Ballantrae, germination and survival of the seedlings was poor, probably because of insect damage. Where legumes have been oversown on to bare soil surfaces after root raking, the influence of time and rate of phosphate and nitrogen fertiliser on establishment is being measured.

Species evaluation. — Under the moist conditions at Ballantrae, Pitau white clover has greater winter growth potential than the standard cultivar, Huia, under hogget grazing. The contribution of oversown Huia white clover, Turoa red clover, Maku *Lotus pedunculatus* and Woogenellup subterranean clover to pasture production under a range of fertiliser inputs and grazing managements is being studied.

Under dry hill country conditions in North Canterbury, the potential contribution of improved strains of red and white clover, *Lotus corniculatus* and a range of grass species including perennial ryegrasses, cocksfoot, *Bromus* and *Phalaris* cultivars is being determined in various farm situations.

Pasture management. — A major activity on the Ballantrae hill country research area in the past four years has been to establish a 110 hectare pasture management experiment consisting of 10 self-contained farmlets. Treatments include rates of fertiliser application and a range of grazing managements thought to differ in severity of legume grazing pressure.

The aims of the experiment include a definition of potential pasture and animal productivity, particular emphasis being placed on the part played by legumes. A full range of measurements of pasture production, composition, and structure is being maintained along with careful monitoring of animal performance.

Efficiency of fertiliser usage is of particular interest because of the low fertility of New Zealand moist hill country soils and the increasing cost of fertilisers. Soil nutrient status and activity, efficiency of aerial distribution of fertiliser, rate of nitrogen fixation, transfer of nutrients by animals, and losses from the system in run-off are being monitored with assessment of pasture and animal productivity. In addition, co-operative projects with the Ministry of Agriculture and Fisheries and Entomology Division of DSIR have been established to measure aerial flight patterns and soil populations of porina and grass grub.

The large-scale experiment is a realistic demonstration of alternative systems and their associated potentials and weaknesses for farmers, advisers, and scientists.

Fertiliser requirements. — Small-plot trials at Ballantrae provide background information on soil nutrient status and fertiliser requirements for pasture growth, the effects of pasture species composition on response to fertiliser and the requirements of improved legumes oversown into the existing sward.

Weed control. — Gorse infests many hectares of hill country and is most difficult to control. It is spiny and unpalatable after the early seedling stage, and is resistant to many herbicides. The influence of pre-burn treatment on post-burn stump and seedling growth has been examined, and future work will include the influence of management on susceptibility of pasture to gorse seedling invasion.

High fertility lowland pastures

Agronomic and ecological evaluations have been carried out continuously at the central station of Grasslands Division.

Initial agronomic assessments. — Environmental adaptation and potential productivity of a wide range of pasture plants are determined for spaced plants or monoculture swards.

Ecological adaptation. — Naturalised populations of ryegrass, browntop, and white clover have been collected, mostly from wet hill country, although detailed analysis has been carried out at Palmerston North. As far as these ongoing programmes allow, the physiological basis of adaptation of these populations, and genotype-environment interactions have been defined, and the course of natural selection in sown pastures has been measured.

Establishment and suitability for grazing. — Although initial screening may show plants to be adapted to climate and soils and high yielding, they may be difficult to establish economically or unsuited to normal grazing management.

Lotus, because it is resistant to pasture pests, does not cause bloat and has low phosphate requirements, is of considerable agronomic interest, but is difficult to establish and maintain in association with ryegrass and/or white clover on fertile soils. Maku lotus is being compared with Huia white clover in the presence of Manawa and Ruanui ryegrass under two grazing pressures. S170 and G4710 tall fescue are also being compared with Ruanui ryegrass under hard and lax grazing.

Mixtures. — Several studies have been about the competitive interactions between sown species and weeds. Comparison of 70 mixtures based on six legumes and nine grasses under grazing for three years at high and low nitrogen levels resulted in several being used in larger-scale grazing trials. Mixtures based on Matua prairie grass; Tama, Manawa, and Nui ryegrasses; and the red clovers, Hamua, Turoa, and Pawera, are being evaluated under two frequencies of grazing, and Nui ryegrass, tall fescue, and phalaris with either white clover or white and red clovers are being investigated under different stocking pressures. Ladino x Grasslands 4700 white clover crosses are being evaluated in the presence and absence of ryegrass competition at two frequencies of grazing.

Litter ecology. — The association of facial eczema and possibly other livestock disorders with ingestion of pasture contaminated with fungal material has prompted detailed studies of the effects of: pasture management during summer and autumn on botanical composition and

spore loads of *Pithomyces chartarum;* early summer management on the availability and decomposition of ryegrass litter within pasture; spraying with benzimidazole fungicides on earthworm activity and litter removal from pastures; and urine patches on sheep grazing patterns.
Weeds, pests and diseases. — Management methods to control diseases such as crown rust; pests such as porina, argentine stem weevil, and slugs; and weeds such as barley grass and thistles have been investigated.
Population dynamics. — Factors which influence the numbers of tillers and shoots of desired grasses and legumes in pasture have been studied. The role of tiller pulling and natural re-seeding in the stability of *Bromus catharticus* swards has been measured, and the vegetative spread of ryegrass clones by rhizomatous-stoloniferous extensions of the tillers has been recorded.

Dryland pastures

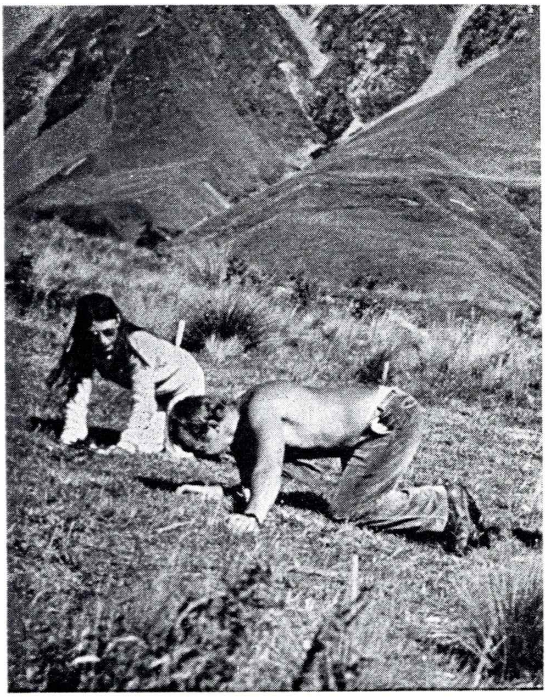
Since 1971 pasture experiments have been located at the Kirwee site on a typical light-land soil of the Canterbury Plains. An assured autumn moisture supply for the establishment of overdrilled Tama ryegrass to provide late winter-early spring greenfeed for lambing ewes has enabled stocking at 27 ewes per ha compared with 15, but at such a high stocking rate, lambing has been later and early weaning of lambs has been required. Growth of overdrilled Tama on dryland has been poor from sowings in dry autumns, but satisfactory from sowing into a cultivated seedbed after summer fallow.

Irrigation can effect the greatest production improvement on dryland, but it is not generally available. Research on sheep production on dryland is therefore on combinations of species expected to do well without irrigation. These are Nui ryegrass, a Grasslands improved variety of cocksfoot, Pawera red clover, and Huia white clover, in comparison with standard Ruanui ryegrass-Huia white clover pasture. Nui ryegrass was not specifically bred for dryland conditions but it has shown in some cases better autumn recovery than Ruanui ryegrass.

As part of a nation-wide experiment, the seasonal pattern of nitrogen fixation was determined for grazed ryegrass-white clover pastures at Kirwee under dryland and irrigation. Elsewhere on the Plains it was shown for old dryland pasture overdrilled with ryegrass that response to nitrogen fertiliser was low in the winter, but good in the growing season. The yield of clover was low. Huia white clover is persistent but not productive on dryland in summer; where irrigated, its nitrogen fixation in summer is less than in spring, even though its growth is good. Future research will attempt to provide a white clover variety that has overcome these problems.

Much of the research on seed production carried out by Grasslands Division is centred in Canterbury. Considerable work has been done on culture of grass seeds and on aspects of pollination of red clover. By modifications in seed production practices (influencing the order of tillers from which seed is obtained and the timing of its nutrition), changes in seed dressing practices, and possibly plant breeding, the main seed weight of lines of 'Grasslands Tama' ryegrass can be increased. This results in more vigorous lines, which establish more rapidly and show better regrowth.

He has not lost a contact lens. It is necessary to get right down to the job to assess establishment of grasses and clovers sown into tussock areas such as this one, in Mackenzie Basin high country.



High country pastures

A research programme in the high country must encompass a mosaic of soils, climates and plants, and be aimed toward different degrees of farming intensity interlaced with other multiple land uses. Complexity arises from the effects of changes in the economics of farming, in national needs, and in attitudes to soil and water control.

Recent research of Grasslands Division in the Mackenzie Country has given greater understanding of processes which had been applied with varying success to the high country at large. For example, studies of the relationships between plants, climates, and soils in a high rainfall zone elucidate soil-forming processes at different altitudes and aspects. Research on the effects of ground cover on seedling establishment from surface sowings allied with information on soils should foster successful oversowing.

Management studies have provided increased knowledge of the components of the diet of the sheep and of the effects on sheep production of improved tussock grassland utilised along with unimproved grassland.

Hydro-electricity schemes remove land from agricultural production, but allow developments such as irrigation to be used to provide alternative supplies of feed for stock. On fertile fan soils very high levels of herbage production have been obtained from grasses and legumes; on the stony less fertile outwash soils there are many problems.

Most of the high country will always be dominated by native grassland, shrubland, and herb fields, and there will be a continuing need for further understanding of natural distribution of vegetation, and how it is modified by grazing, soil and water control, or nature conservation.

Cool temperate (Southland) pastures

Pasture in Southland has a very low rate of growth in the winter (less than 10 kg/ha/day) relative to most other regions of the country, followed by a rapid increase over the spring to reach a peak of around 70 kg dry matter/ha/day in November. There is then a slow decline in growth rate, with no marked summer depression, and no marked autumn flush. At the Gore Regional Station of Grasslands Division, pasture growth averages 14 000 kg/ha within a range of 11 000-17 000 kg.

Pasture establishment. — The value of overdrilling to incorporate new varieties of pasture plants into existing pasture is being assessed. Significant improvements in winter feed have been obtained, especially by the use of Tama ryegrass and Rahu ryecorn. Yields are significantly affected by time of sowing, time from sowing to first grazing, and by the weather prevailing during the autumn.

Species performance. — Studies have indicated that 'Grasslands Nui' perennial ryegrass has a yield superiority over other ryegrass species in Southland (a result verified in many other regions of New Zealand) and that 'Grasslands Pawera' red clover has a very important role to play in the production of summer feed there. During the three months of summer, yields from red clover have been more than twice those from permanent pastures. In addition nine pasture mixtures under two

Assessing the density of flower production in a seed crop of 'Grasslands Pawera' tetraploid red clover. The species is assuming importance for production of summer feed in cool temperate regions.

Knowledge of these junctional structures is important to the understanding of bodily functions in health and sickness. Many diseases can be related, at least in part, to some malfunction of these communicating or bonding systems; for example some nervous disorders and some cancers are characterised by lack of cell-to-cell communication and adhesion. DSIR scientists are investigating various aspects of intercellular communication and adhesion, the work being based mainly on invertebrate tissues because these present a greater variety of junctional structure than is found in vertebrates. New variations in detailed structure of junctions have been found, and it is hoped that these will lead to a better understanding of the way in which structure is modified for specific purposes.

Studies of myelin

Most of the nerve axons in higher animals are surrounded by sheaths of myelin. These sheaths are important to the functioning of the nerves, and consist of multiple layers of membranes derived from the plasma membranes of Schwann cells or glial cells, wrapped in spirals around the axon.

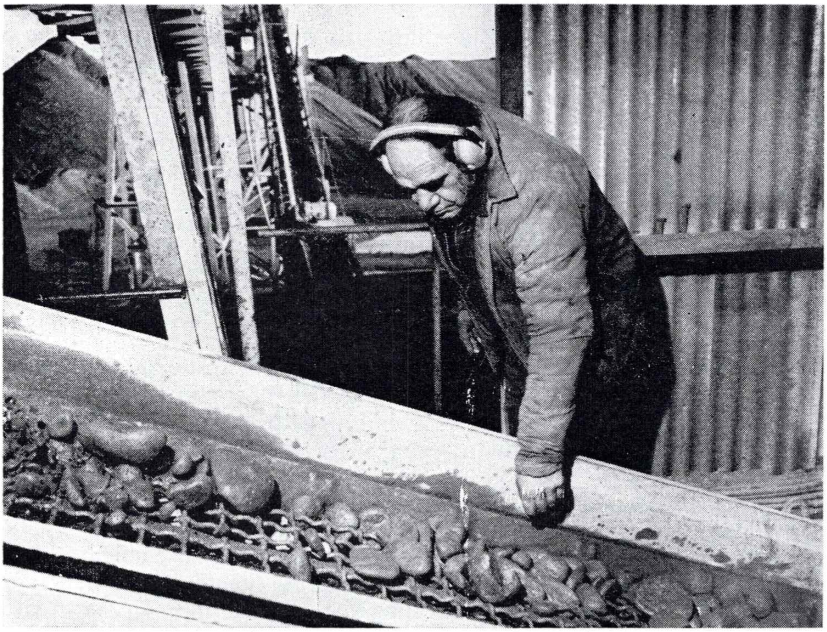
As a convenient source of experimental material, studies have been made of sheaths in the lateral nerve of fishes. It is found that the membranes are joined at certain positions by junctional elements which delineate compartments and channels within the sheath. These structures are probably significant in controlling the permeability of the sheath, in maintaining its shape, and in nutrition and repair processes.

Cancer research

The possibility of using nuclear magnetic resonance as a technique for the early detection of cancer is being explored. Experiments on mice with artificially induced cancers have shown that as cancer develops it affects most organs, probably by upsetting the water regulatory mechanism. Nearly half of these cancers in mice could be detected by pulsed nuclear magnetic resonance measurements on the blood alone. To determine whether or not this also applies to humans, a large-scale experiment is planned to measure the nuclear magnetic resonance of blood from normal people and from cancer patients. Such measurements show promise of being clinically useful in the detection or monitoring of cancer in humans, and as a routine and rapid (although probably non-specific) means of screening patients for blood abnormalities.

CONCLUSION

Although most research on human health is supervised by the Medical Research Council, DSIR is carrying out a large research programme supervised by the National Research Advisory Council. Liaison between these two Councils, and between DSIR and the Department of Health, ensures coordination of the programmes. The constant vigilance of the Department of Health and DSIR in monitoring and checking foods ensures that the public can have confidence in the purity and safety of the foods offered for sale. Other work by DSIR is expanding our knowledge of nutrition and assisting in the treatment of disease. In all, DSIR spends close to a million dollars annually on work relating to human health.



Methods of evaluating damage to hearing from noise are being developed. Here a worker at a gravel-crushing plant is wearing protective earmuffs.
Photo: National Publicity Studios

Anti-inflammatory agents in New Zealand mussels

Extracts of the native marine green-lipped mussel *Perna cannaliculus* are claimed to be able to alleviate the symptoms of arthritis, although convincing medical evidence for this claim has not yet been obtained. Published research work on the constituents of some related marine animals suggests that there may be some secondary metabolites present in mussels that can be converted within the human liver to products related to natural anti-inflammatory compounds. A project to investigate the nature of these metabolites has been started. It is hoped to determine (by analogy with other known anti-inflammatory agents) whether these metabolites might be responsible for the purported therapeutic activity of the mussel extracts.

Membrane junctions

Communication between the various parts of an animal (including man) takes place by a variety of processes including nerve conduction, hormone secretion, and, at the cell-to-cell level, by the transmission of signals via specialised junction structures on the cell membranes. Other types of junctional structures are involved in maintaining adhesion between cells and thus holding tissues together, and in sealing the spaces between cells to restrict the movement of body fluids to specific paths. Examples of the latter occur, for example, in the gut to separate gut contents from the bloodstream, and in the urinary tract to separate wastes from the rest of the body fluids.

establish a baseline of marine hydrocarbon pollution before development of Maui, against which the effects of development can be assessed.

Nuclear fall-out

Fall-out from bomb tests has become of world-wide concern, and DSIR has lent a staff member to work with the United Nations Scientific Committee on the Effects of Atomic Radiation, who are preparing a number of international reports on the effects of radiation from nuclear fall-out on human health. Most of the monitoring of fall-out formerly carried out by DSIR is now included in the extensive monitoring programme of the National Radiation Laboratory of the Department of Health. However, DSIR has continued to measure a number of radionuclides such as caesium-137, strontium-90, and several short-lived species, in both rain and sea water. These data have been useful for determining the external gamma radiation dose to humans from fall-out, and are the only systematic data available for this purpose in the Southern Hemisphere which deal with short-lived radionuclides.

Noise in the community

Noise pollution is increasing in the urban environment, for example many complaints from schools have concerned high noise levels in classrooms from traffic. DSIR research on noise pollution has taken two basic directions. The first has been to improve the techniques for measuring noise and studying "special" types of noise in order that the effect on people can be better understood, and the second has been to apply noise measurements and analysis in a study of noise intrusion into everyday living.

Impulsive noise is one of the more important types of specialised noise being studied. Particularly damaging to hearing, impulsive noise is not fully understood, and so parameters such as rise time, peak level, rate of occurrence, and decay time, are receiving attention. The time spent so far has been directed towards evaluation of experimental techniques, particularly for measuring impulses of shorter duration. Special methods need to be developed to evaluate the damage to hearing from this type of noise.

In environmental studies, traffic is the predominant noise source, and surveys are being carried out on the variation of noise under different conditions. Information is being accumulated on its attenuation through the walls and windows of buildings, and manufacturers have been assisted in the design of more effective silencers for motor vehicles. Surveys have also been made to plot noise contours that can be used to assist those concerned with the zoning of land around airports.

BASIC MEDICAL RESEARCH

Many of the special research facilities installed by DSIR for other purposes have been found to have applications in basic medical research. Such research is always done in close collaboration with medical research groups, usually in universities.

was broadly comparable with the very low rates of ingestion demonstrated in other advanced countries. This reflected favourably on New Zealand's research-based agricultural practices, particularly in view of the unique problem of grass grub control in farming.

A further study of human fats has recently been completed in which the contents of a range of pesticides (including DDT) and of the industrial chemicals, polychlorinated biphenyls (PCB), were determined. This work confirmed the findings of the earlier study, and demonstrated a decline in the DDT content of human fats, reflecting the major reduction in DDT use during recent years. It also showed that PCB residues are widespread in New Zealand, as they are in industrial countries abroad, but that the levels of these residues are low.

Waters draining agricultural land on which DDT has been extensively used in the past have been monitored twice yearly for pesticide residues between 1965 and 1972. No trace of DDT or any other persistent organochlorine insecticide has been found in these waters above 0.05 part per thousand million, the limit of measurability of the method used.

Vinyl chloride

One of the most distressing circumstances in industrial health research is the way in which chemicals, initially considered harmless, have been later discovered to be serious health hazards. Typical past examples are lead, radium, beryllium, carbon tetrachloride, and asbestos. The latest chemical to follow this pattern is vinyl chloride. Overseas observations of a number of cases of a rare form of cancer among people who work for long periods in polyvinyl chloride factories have revealed the latent carcinogenicity of vinyl chloride, the chemical from which PVC plastic is made.

Concern has been expressed that finished PVC articles might contain significant quantities of vinyl chloride, which could then enter foodstuffs packaged in the articles. Chemistry Division has developed a sensitive analytical technique capable of assessing the vinyl chloride content of both PVC and foods at the level of 1 part per thousand million. In conjunction with the Department of Health, a study of food items normally packaged in PVC has shown that certain foods contain vinyl chloride at considerably higher levels than the 0.1 part per million guideline level. The vinyl chloride content of rigid PVC used for packaging varies enormously, depending on manufacture and age. Analysis of various commercial PVCs has assisted food packaging firms to select those stocks of PVC low in free monomer, thus ensuring that in future foods will contain negligible concentrations of vinyl chloride.

Hydrocarbons in the marine environment

Low levels of hydrocarbons from the sea can accumulate in marine organisms, and fears have been expressed that fish and shellfish from the Taranaki coast could become tainted with oil after development of the Maui natural gas and oil fields.

At the request of the Ministry of Agriculture and Fisheries, analyses are being made for hydrocarbons in mussels taken from around the New Zealand coast, particularly from Taranaki. It is hoped to bonito, mackerel, skipjack, or tuna, all in a group known as Scombridae, stored under unsuitable conditions. Toxic fish may still appear to be "fresh". Food poisoning incidents since referred to DSIR have involved similar symptoms associated with non-scombroid fish such as kahawai, kingfish, and salmon.

Where possible, extracts were prepared from suspect fish samples and their toxicity assessed (with the aid of the National Health Institute) by a bioassay involving guineapigs. The toxins from scombroid and non-scombroid fishes were isolated and shown to be chemically identical. Thus the previous association of the toxin with scombroid fishes appears to be fortuitous, and may result from their commercial predominance in some parts of the world. The fish species presenting most risk would seem to be those containing relatively high levels of toxin precursors, i.e., those with naturally high levels of histidine.

Space heating by combustion

Natural gas, in contrast to coal gas, does not contain carbon monoxide in toxic amounts, and in those areas where natural gas has replaced coal gas as a town supply there has been a significant lessening of poisoning cases, particularly suicidal. But unless a gas-burning appliance receives an adequate air supply to ensure complete combustion, appreciable amounts of carbon monoxide may be formed. DSIR staff have helped investigate a number of accidental fatal asphyxia cases arising from faulty operation of natural-gas appliances. A recent case concerned a propane heater, for which faulty operation and inadequate ventilation caused a build-up of carbon monoxide, resulting in death of two occupants of a caravan.

Quick method for study of atmospheric pollutants

Identification of trace elements in the atmosphere is important for the protection of public health; but because of the very low amounts present, analysis can be difficult and time-consuming. A technique recently developed at the Institute of Nuclear Sciences has greatly simplified the process.

Air is drawn through a filter for about an hour, and the trace elements in atmospheric particles are trapped. The material is then bombarded with protons from a Van de Graaff accelerator to excite the elements present, and the resultant X-rays are examined. Each element emits X-rays of a different energy, so most elements can be determined simultaneously in about 5 minutes. This technique is called "proton-induced X-ray fluorescence". Lead and bromine are prominent among constituents of air collected near motorways, and since a short sampling time is feasible, the change of concentration of these toxic elements with time can easily be determined. The technique is useful for measuring other trace elements, and has been applied to a wide variety of air samples.

Organochlorine chemicals in the environment

Studies have continued of the presence in the environment of persistent organochlorine insecticides, particularly DDT. A survey of the content of organochlorine insecticides in human depot fats in New Zealand in the 1960s had shown that ingestion of residues of these compounds

A skipjack tuna being measured in a fisheries sampling programme. Under unsuitable storage conditions, some fish, especially tuna and related species, develop toxins which can cause scombroid poisoning.
Photo: National Publicity Studios

Total diet survey

Although monitoring of pesticide residues in horticultural crops assists in controlling the uses of pesticides, it is not possible to deduce from it the overall level of dietary intake of common pesticides. A survey of the total diet has therefore been undertaken and is now well advanced.

It has been based on detailed assessment by Health Department dietitians of the composition of the total diet of a young adult male. Appropriate sampling of foods has been carried out by Health Department officers at Auckland, Wellington, Christchurch, and Dunedin on four occasions over one year. The foods so sampled have been subdivided into appropriate categories, and are being analysed for organochlorine and organophosphorus pesticides and for a range of toxic elements. The nutritionally important and related factors, calcium and phosphorus, are also being assayed.

"Scombroid" poisoning

In 1972 officers of DSIR were asked to investigate an incident in which a family suffered from food poisoning after eating a can of smoked mackerel. The symptoms reported, typical of "scombroid" poisoning, included headache, dizziness, dryness of the mouth, palpitations, massive red welts on the skin, and diarrhoea. All the victims recovered within a day. "Scombroid" poisoning is usually associated with eating maximum residue limit figures established by the Department of Health. The analytical methods involved often have to identify and measure trace chemicals at levels in the order of 0.1 part per million in the crop.

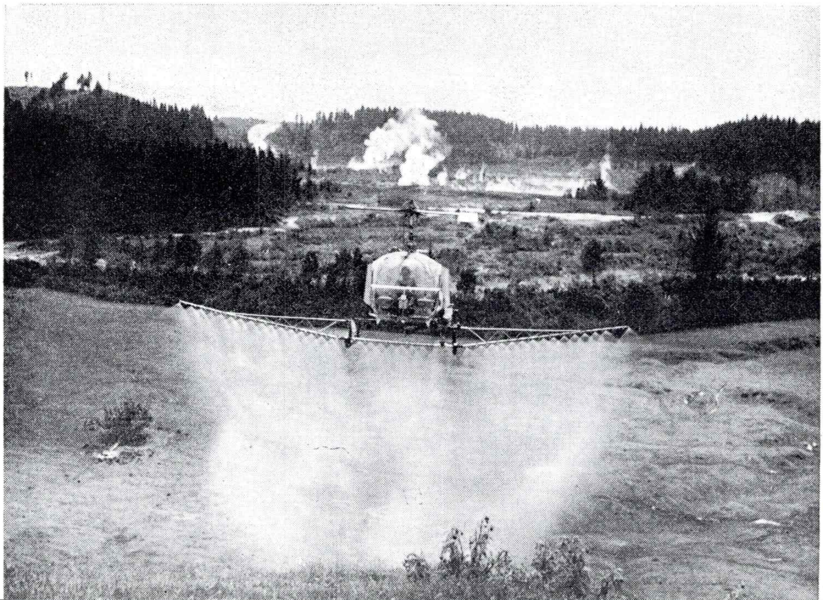
In addition to extensive research to ensure that approved pesticides can be used safely, fruit and vegetable samples from the retail markets have been regularly tested for over 10 years to investigate the effectiveness of control measures. About 200 samples per annum have been tested, selected according to pre-arranged schedules to ensure that a wide range of produce, and all geographical areas, have been fully surveyed. Although up to 30% of samples have contained detectable residues, such residues have rarely been above the permitted limits.

In addition, annual testing has been carried out on up to 150 selected samples of apples for particular pesticides known to have been used on them. The results of this work have also indicated that in most cases residues are below the permitted maximum limits. Information obtained is made available, where appropriate, to World Health Organisation committees concerned with pesticide tolerances in relation to human health.

Dioxin in 2,4,5-T herbicide

Once it had been established overseas that earlier formulations of 2,4,5-T could contain significant amounts of dioxin, a teratogenic impurity, the Agricultural Chemicals Board ruled that formulations of this herbicide in New Zealand should contain not more than 0.1 part per million of this impurity. In the absence of any evidence of teratogenic effects on humans arising from the use of 2,4,5-T, this decision was made on grounds of prudence in line with decisions by relevant countries abroad. Since the dioxin in question is an inevitable byproduct of precursor compounds in the synthesis of 2,4,5-T, it has been necessary to monitor analytically the 2,4,5-T produced locally or imported since April 1973. Such monitoring has revealed no failure to meet the quoted requirement.

A helicopter spraying gorse and thistles with 2,4,5-T herbicide. DSIR tests samples to ensure that the content of dioxin is below prescribed limits.
Photo: National Publicity Studios



Particular care is needed to ensure that special-purpose foods provide an adequately balanced diet. Studies of canned baby-foods have shown the need for vitamin C supplementation if they form a major part of the baby's diet.

are the highly toxic elements which as far as is known are unnecessary to the body; these include lead, cadmium, mercury, and arsenic. Between these extremes are a group of five essential metals (copper, cobalt, zinc, manganese, and molybdenum), without which the body cannot function, but which in excess exhibit some toxic effects. Of the remaining naturally occurring metals, a good many are both eaten and customarily present in the body, but what they do, or whether they have to be present, is unknown.

By analysis of tissue samples from the New Zealand population, base levels have been established for metals on a comprehensive scale as an index of metal ingestion. It is expected that the findings will provide a basis for future reference, and will lead to a better appreciation of the significance of toxic hazards arising from exposure to metals in the environment. Results indicate that there is no evidence of excessive metal intake. There is a close agreement between current results and the limited information available from overseas studies.

Pesticide residues in food

Numerous highly toxic pesticides are used by commercial fruit and vegetable growers, and it is known that traces of chemical residues may survive on some crops beyond the time of harvesting. From work overseas to determine residues actually present in the average total diet, it appears certain that the survival of normal pesticide residues and the regular consumption of them in food do not threaten public health provided that pesticide usage is subject (as it is in New Zealand) to adequate regulations and controls.

While pesticides continue to be needed in agriculture, research and monitoring of chemical residues must be maintained. This work is done cooperatively between Ministry of Agriculture and Fisheries and DSIR. New pesticides or new uses of pesticides are not permitted in agriculture unless preliminary research has shown that residues arising from the proposed uses in the relevant crops are either negligible or are below and their impact on waste recovery is being assessed. These new canning techniques do not appear to raise any new problems, but continuing product surveillance will be needed to ensure that no new health problems occur.

Nutritional value of food

While it appears that the nutritional status of most people in New Zealand is satisfactory, more information is needed about the nutritional qualities of special-purpose foods, for example, for infants, or for medically limited diets.

Earlier investigations of the vitamin C content of locally produced canned baby foods showed that the amounts present were low in comparison with the desired minimum standards, if such products were to constitute the major part of the fruit and vegetable component of the diet. These studies are now being extended to cover the major vitamins and other important nutritional factors in all foods manufactured for infants.

A limited compositional study has been carried out on selected items of hospital patients' diets, such as soups, stews, fruit pies, and puddings. These were analysed for total nitrogen, carbohydrate, total fat (with its cholesterol and fatty acid composition), calcium, and iron. These substances are significant in certain types of illness, and analytical data obtained about them are being compared with theoretical calculations from published data which had previously been the sole source of information about the individual ingredients of foods.

In another investigation, sodium and potassium levels are assessed in the total diets of groups of patients receiving high and low sodium intakes, to assist in correlating such intakes with urine composition. This is intended for use as an epidemiological tool to assess sodium intakes in diets.

Toxic metals from food utensils

Some risk to health still exists from exposure to lead contamination of food from improperly fired or constituted lead glazes or enamels on food containers. A simple screening test has been devised and is now being used by Health Department inspectors. Although most items tested so far have proved to be satisfactory, attention has been drawn to some which failed to comply with current regulations and to at least one example that was potentially dangerous. Monitoring of this nature is continuing.

Concern was expressed by the Department of Health that certain imported highly coloured enamel goods could have unacceptable levels of cadmium, and a number of items of the kitchenware in question were examined for their ability to release cadmium to food contained in them. The majority of the articles tested were found to be of satisfactory quality in this respect.

Trace elements in human tissues

The impact of ingested metals on man can be divided into four main categories. On the one hand, a number of metals, such as calcium, iron, sodium, potassium, and magnesium, are essential to man, and there are no known toxic effects arising from them. On the other hand there legally permitted levels are not exceeded, and that any illegal use can be detected. An example of such an investigation is the application of gas-liquid chromatography and thin-layer chromatography to identification and measurement of benzoic and sorbic acids and related compounds commonly used as preservatives. Methods for other additives are similarly being reviewed and evaluated, and (where suitable) applied to routine use.

Food contaminants

The investigation and analysis of contaminants in food are of the utmost importance for human health, and analytical methods are constantly improved. Contaminants include adulterants added to replace or dilute essential constituents; and although today such additions may not be so common or so directly harmful as was often the case in the past, they must be rigorously excluded. Other contaminants include the gross accidental addition of foul objects, chemical contamination suffered in storage or transport, vague taints and odours which sometimes are accidentally acquired, and finally the contaminants associated with modern technology in agriculture and food processing which cannot be entirely avoided.

Introduction of container and other modern shipping techniques has created new problems of corrosion and damage of canned goods during transit. These are being studied, and steps are taken to ensure that the food trade knows how to avoid dangers of product deterioration during transit.

Polyaromatic hydrocarbons in foods

Polyaromatic hydrocarbons are a group of organic chemicals well known to cause cancer in animals. These compounds are produced by normal combustion processes, and have been found at low concentrations in smoked foods and in products such as margarine and vegetable oils. Officers of DSIR collaborated in an international assessment of an analytical method developed to determine very small concentrations of polyaromatic hydrocarbons in foods, and the method has now been used to study foods likely to contain these compounds. New Zealand vegetable oils, animal fats, and smoked foods have been examined, and have been found to contain very low levels (less than 10 micrograms per kg) of individual polyaromatic hydrocarbons. These concentrations are well within acceptable levels.

Tin and lead in canned food

Because of the levels of lead discovered in the past in canned baby foods and carbonated beverages, the manufacturers of these products have been guided in changing their canning procedures for these products to avoid the use of lead solder. The can makers now use pure tin for the side seams of conventional cans. There is thus no longer any objection to using lacquer in these cans (in the past this increased the possible dangers of lead contamination), and manufacturers will therefore be able to use lacquer coatings to avert dangers of tin contamination from corrosion products.

The advantages of using different modern canning processes such as the two-piece aluminium can, or black steel can, have been reviewed,

The composition of waters receiving various effluents is sampled. With help from laboratories around the country, Chemistry Division operates a programme to compare analytical procedures and accuracy so that acceptable water quality can be maintained.

Quality of foods

In accordance with a pattern established in co-operation with the Department of Health, samples of typical foods are regularly tested for compliance with the standards of quality and safety laid down in the New Zealand Food and Drug Regulations. These samples include dairy and meat products. Assessments are made of the proportions of natural, essential constituents to ensure that the important dietary ingredients are present in sufficient amount. Milk and dairy products are examined by long-established standardised methods; but other analyses may involve a number of assumptions and approximations that are difficult to substantiate fully, for example, the identity and amount of meat in a sausage or meat pie using traditional analytical procedures of determining organic nitrogen and fat. More specific methods based on a characteristic amino acid or protein ingredient will be kept under review, for possible adaptation to routine use.

Food additives

There is a need to determine the nature and amount of foreign substances deliberately added to foods to produce a desired effect. These substances include preservatives, antioxidants, colouring materials, conditioners, flavouring substances, and sweeteners. It is important that only permitted harmless substances be used and that, where they are permitted, the amounts used are not excessive. Improved methods for detection and analysis are continually being developed to ensure that strated that a proposed new scheme, based on a sample of prescriptions, would violate current legislation limiting possible underpayment to $\frac{1}{2}$%. This assistance should help the Health Department in related areas, and provide them with better control over the estimated $70 million paid out annually in benefits. For example, analysis is to be done on the accuracy of their current sampling scheme designed to estimate the total usage and cost of drugs.

Quality of waters

Laboratories in a number of organisations now undertake chemical analyses to assure the quality of drinking waters and swimming waters. To assist these laboratories assess and improve their analytical methods, Chemistry Division operates an inter-laboratory collaborative analysis programme (the CHEMAQUA programme) in which samples of known composition are distributed to different laboratories for analysis. Comparison of results from a number of different laboratories has often indicated shortcomings in the reliability of chemical analysis, particularly for nitrogen and phosphorus.

Although the number of water analyses performed on behalf of the Health Department has remained virtually constant for a number of years, the range, reliability, and precision of analyses are being progressively improved. For example, where some analytical methods were capable of determining only whether or not a constituent was present at a concentration exceeding a potable water quality requirement, most methods now in use determine the actual concentration of the constituent present, even when this concentration may be many times lower than the potable water limit. Such information assists in understanding the factors controlling water quality, and can therefore provide assurance of continuing acceptability of water quality. These analytical improvements have required a considerable investment in assessing and developing analytical methods, sampling methods, and sample preservation and storage techniques.

Investigations of the effects of volcanic eruptions on water quality have established the absence of health hazards associated with the presence of large concentrations of ash from eruptions of Mt. Ngauruhoe. Eruptions of Mt. Ruapehu cause large increases in acidity and fluoride content of receiving waters. It has been established that waters potentially contaminated by fallout from a Ruapehu eruption are safe for water supply use, provided that the pH is above 6.5. Such guidelines enable local authorities to operate their water supply systems during periods of potential hazard with a minimum of disruption, while at the same time ensuring the absence of adverse effects.

There is increasing interest in the application of sewage effluents to land as a means of minimising the input of nutrients and organic materials to receiving waters. Chemistry Division investigations assist in determining the operating efficiency of some existing land disposal systems, to minimise potential health hazards such as contamination of underground water supplies. Such investigations are particularly important in Canterbury, and assistance has been provided for the studies by the Ministry of Works and Development and Lincoln College at the Templeton and Burnham land disposal systems.

of these bottles, they are commonly reused. Therefore, the attack of infusions on the glass surface is being studied.

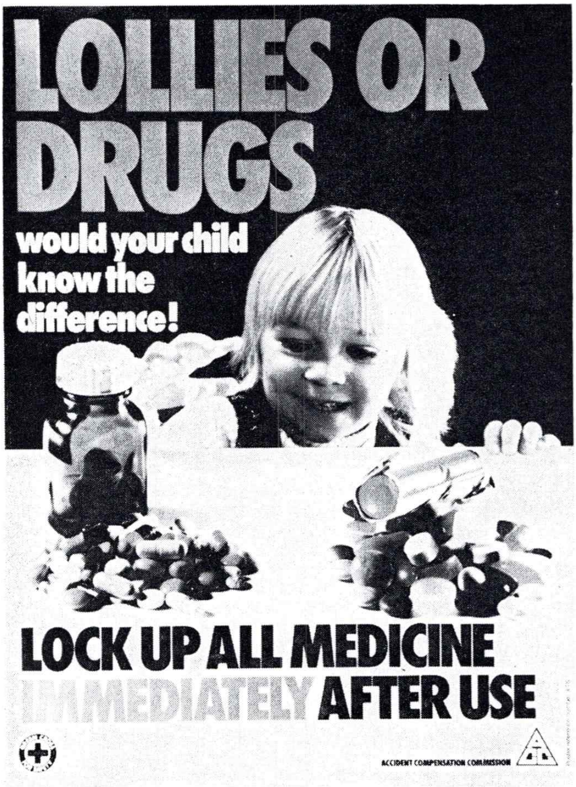
Analysis showed that the yellow colour in some intravenous saline solutions manufactured in New Zealand was caused by a diphenoquinone, which had been produced by oxidation of an antioxidant leached from the polypropylene air tube in the bottle. The presence of the diphenoquinone is undesirable, and draws attention to the need for careful choice of the plastic used in such applications. The problem in this case was solved by replacing the polypropylene tube with one made of unstabilised polyethylene.

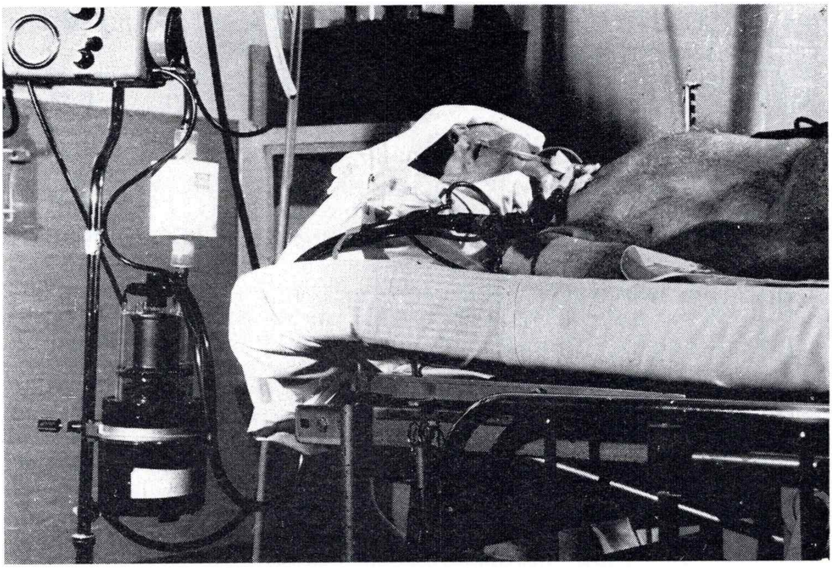
A manufacturer's morphine injections appeared to have consistently low morphine content but this turned out to be a problem of the analytical technique, being due to interference by the preservative used.

Prescription drug sampling

The Department of Health operates a scheme to reimburse each pharmacy based on the cost of prescriptions. DSIR statisticians demon-

Pharmaceutical tablets are manufactured to high standards of quality control, but DSIR does periodic surveys of pharmaceutical products to ensure that standards are maintained. The poster was used by the Accident Compensation Commission and the Chemists' Guild in a campaign to reduce accidents in the home.


LOLLIES OR DRUGS
would your child know the difference!
LOCK UP ALL MEDICINE IMMEDIATELY AFTER USE
ACCIDENT COMPENSATION COMMISSION



The humidifier is used to control the moisture content of air delivered direct to the lungs of patients whose nose and throat have had to be bypassed in surgery.

The detection of even minor faults prompts the Department of Health to invite a manufacturer to improve his manufacturing practice. To assist manufacturers in assessing the quality of their manufacturing practices, DSIR has issued a questionnaire, and has published manuals and other information on good pharmaceutical manufacturing practice.

Dissolution of drugs

Four types of apparatus are available to measure the rates of dissolution of drugs in oral dosage forms, and the procedures have been automated. The performances of three of these procedures have been compared using pellets of *p*-hydroxybenzoic acid. The rate of dissolution has an important bearing on whether drugs can be absorbed efficiently from the gastrointestinal tract and liberated into the systemic circulation. In cases where difficulties are likely, the apparatus is used to compare different brands of the same drug. A brand of digoxin tablets has been shown to have unsatisfactory dissolution properties. A further apparatus has been developel to assess the efficacy of antacid preparations both in controlling gastric acidity and in absorbing pepsin, and a survey of locally available antacid preparations has been carried out.

Parenteral solutions

A hospital experienced problems with excessive particulate matter arising during storage of an irrigation solution. This was found to be due to corrosion of the screw cap. An apparatus has therefore been designed to study foreign particles in parenteral solutions (injections and infusions).

Health authorities recommend that infusion bottles made of treated soda glass should be used only once; but because of the expense heart variations of a large number of patients. The technique is technically feasible and economically attractive. Arrangements have been made to collaborate with a New Zealand manufacturer to jointly develop a prototype system for evaluation.

Humidification of inspired air

In the Critical Care Department at Auckland Hospital a number of problems have been investigated. Many patients in the department must spend long periods in totally artificial respiration. The respirators provide dry, cool air–oxygen mixtures. The nose and throat are often bypassed by means of endotrachial or tracheotomy tubes, but dry, cool air delivered direct to the lungs causes several serious problems. DSIR has developed a humidifier that ensures that air delivered (at body temperature) to the lungs has a relative humidity in excess of 85% at all breathing volumes. The Critical Care Department in Auckland is fully equipped with this device, and management of patients has greatly improved as a result. This equipment has been developed in close collaboration with a New Zealand manufacturer, and several hundred machines have been distributed. It is patented throughout the world because there is a large export potential, which the manufacturer is exploiting through a well established overseas marketing organisation.

PUBLIC HEALTH

It is better to prevent people from becoming sick than to treat them after they have become ill. The Department of Health operates a large programme of preventive medicine, largely through the offices of the local Medical Officers of Health. This work is backed by DSIR laboratory services. Inspectors from the Department of Health take samples of a wide range of foods, waters, drugs, paint on toys, and other materials ingested by the public, for examination by DSIR scientists for chemical and bacteriological quality, and analysis for the presence of possible poisonous substances. DSIR also assists the Department of Health to maintain the quality of pharmaceuticals, many of which are paid for by the taxpayer.

Quality of pharmaceuticals

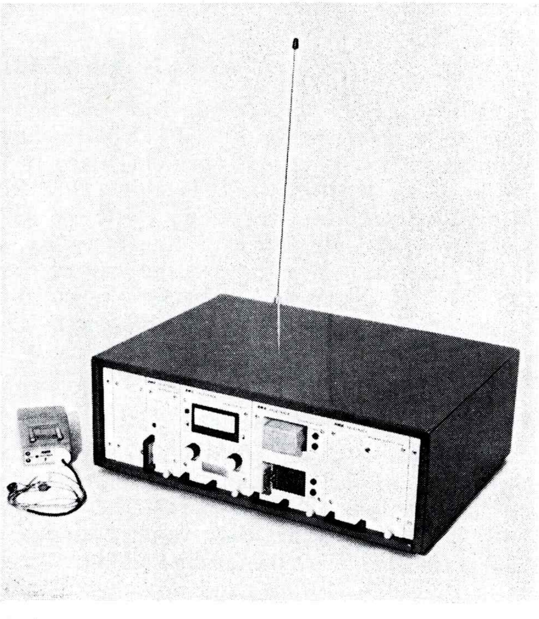
The Department of Health carries out comprehensive surveys of medicines available locally, and samples taken are checked against specification in DSIR laboratories. Surveys completed since 1972 include aspirin preparations, sulphonamides, corticosteroids, penicillins, oral hypoglycemics, tranquillisers, anticoagulants, diuretics, antihypertensives, antihistamines, and a wide range of other medicines.

Most medicines and pharmaceuticals available to New Zealand are of a high standard, but the analyses sometimes uncover sub-standard products. Without systematic surveys, sub-standard drugs might be more common. To date, close to 10% of pharmaceutical products have failed in the laboratory tests, usually because of too low or too high a content of active ingredient. Other major reasons for failure include the presence of impurities, inadequate tablet disintegration after swallowing, non-uniform dosage, damaged or ill-compounded tablets or capsules, inadequate or broken containers, and misleading labels.

An automatic-injection apparatus is therefore being developed. Special precautions have been taken to provide a fail-safe system that shuts down and sounds an alarm if a malfunction occurs. The system uses mainly low-power digital logic, and has been designed with a large amount of redundancy in the circuitry to ensure high reliability. Work on this project is continuing.

Physiological data from mobile patients

In intensive care departments in hospital, the heart action of patients recovering from coronary failure has to be monitored, but it is desirable to allow them to move about the hospital environment, without the restraint of being wired to an instrument. A miniature radio transmitter (about the size of a pack of cards) has been developed which transmits the electrocardiogram and a wide range of other physiological data to a central recorder. Amalgamated Wireless Australasia (NZ) Ltd. (AWA) in Wellington developed the receiver and are now manufacturing the whole system commercially. The AWA equipment is installed at Green Lane Hospital, Auckland, in the intensive care ward, and is operating satisfactorily. The equipment has also found applications in sports medicine, animal physiology, and industry.

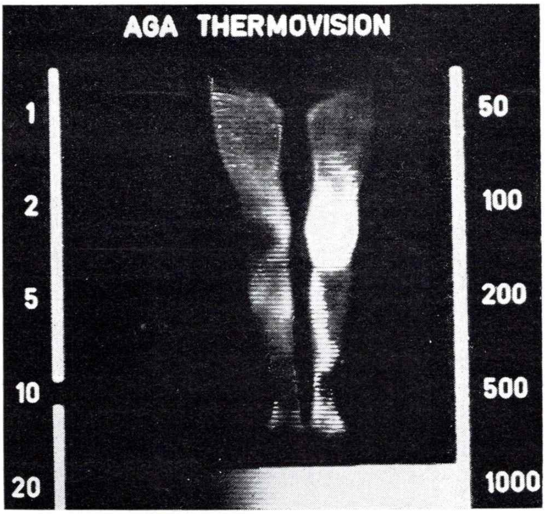


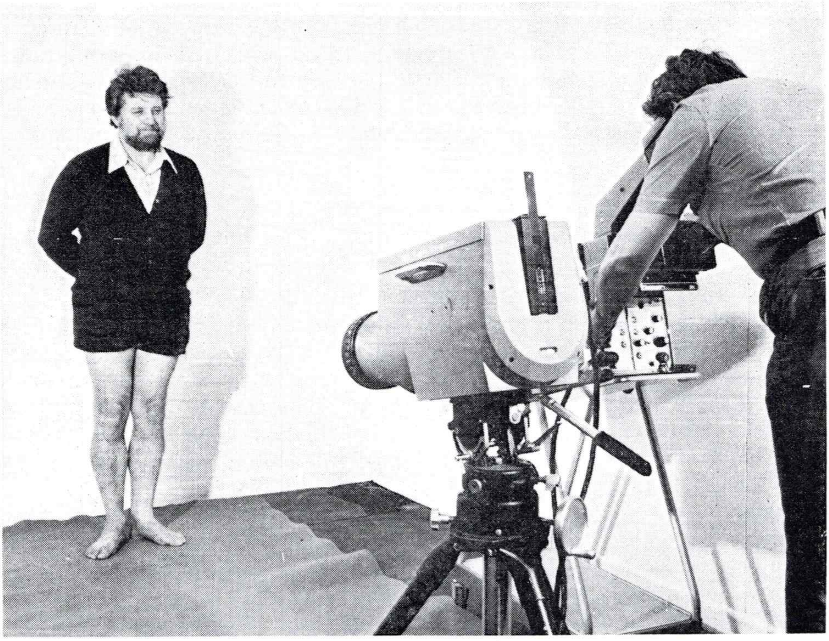
To enable heart patients to move freely about the hospital ward while being monitored, this radio telemeter has been devised. The small transmitter on the left fits into the patient's pocket.

Foetal heart-rate monitoring

Continuous recording of foetal heart-rate variations is a useful diagnostic technique for monitoring the condition of the foetus during childbirth. In the past this technique has been used mainly on selected patients (where there was cause for concern), but there is now a world-wide trend towards monitoring all childbirth patients in this way. DSIR is assisting National Women's Hospital to investigate the use of a small dedicated computer to record and display the foetal

In studies of Paget's disease, thermograms are used to show up higher temperature, indicating the source and severity of affected areas, in this case the knee.





through a very fine indwelling catheter. Quite large doses are injected in a short period, and the dose must be repeated at controlled intervals if the relief of pain is to be successful. If the operation is done manually it requires qualified staff. The procedure is becoming frequently used and would be used even more if a reliable automatic infusion apparatus was available.

HUMAN HEALTH*

DSIR does not have the primary responsibility for research into human health; this lies with the Medical Research Council and the Department of Health, aided by medical schools in the Universities of Otago and Auckland, and by some hospitals. Nevertheless, there are many functions in scientific services for public health, and in research into human health, that DSIR can fulfil more effectively than other organisations, and it has always maintained a large scientific effort in this field. Although the Department of Health (in its National Health Institute, National Radiation Laboratory, and Environmental Laboratory) is responsible for the establishment and surveillance of standards for foods, pharmaceutical drugs, air, water, industrial practices, and environmental pollution, when these activities require additional research, this support is provided by DSIR. DSIR also initiates some research on human health in co-operation with other institutions.

MEDICAL INSTRUMENTATION

Modern medicine has made extensive use of the physical sciences in diagnosis and treatment of disease. Many instruments made for these purposes can be bought overseas, but the high level of medical practice in New Zealand has created demands that overseas manufacturers have been unable to meet, and DSIR has developed special instruments and techniques in collaboration with doctors engaged in research in New Zealand hospitals and universities.

Paget's disease

Paget's disease is a fairly common disorder of bone metabolism occurring in the middle-aged and elderly. In addition to the patient suffering severe pain, the disease causes deformation of bones (particularly in the limbs and skull), deafness, heart strain, and other effects.

DSIR has been assisting Auckland Hospital in a study of Paget's disease by thermographic examination of a large group of patients. 'Thermovision' equipment produces a picture or thermogram in which the image density is proportional to the temperature of the surface. The increased metabolic activity in the affected bone area gives rise to an increase in temperature of the overlying skin, which can be readily detected by the 'Thermovision'.

For each patient in the study group, thermograms taken over the whole body enabled a thermal 'contour-map' to be produced. This was done before treatment began, midway through treatment, and at the end of treatment, which lasted about 6 months. In conjunction with X-ray and other examination techniques, the thermograms delineate the extent and severity of each affected area, and show the changes that occur as treatment proceeds.

Epidural (spinal) infusion apparatus

For the relief of chronic pain and for certain anaesthetic procedures, a drug can be infused directly into the area surrounding the spinal cord

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*This category of work was last reviewed in *DSIR Research 1972*, p.17.

and many plants die after they have flowered, whereas healthy plants go on producing tillers throughout summer. Three fungus diseases of white clover leaves—rust, black blotch, and leaf spot—all reduce clover growth. More importantly, perhaps, it has been shown that infection by these fungi induces oestrogen production in the clover plants, which can affect the fertility of grazing animals.

Bacterial diseases of pasture plants are not of practical significance in New Zealand at present.

In an extensive survey, symptoms of virus infection have been found on all the major pasture grass species throughout New Zealand. It has been established that barley yellow dwarf virus, which is aphid-transmitted, is widespread in ryegrass, and the effect of this virus on grass growth is being investigated. Several viruses are known to attack clovers in New Zealand, and white clover mosaic virus and subterranean clover red leaf virus are widespread. Infection with the latter virus severely limited the growth and longevity of alsike clover.

Pasture decline and animal ill-thrift are problems engaging the attention of plant pathologists. Root-rotting fungi have been shown to restrict clover growth, but their role in the pasture decline syndrome has still to be clarified. The part that microorganisms living in pasture might play in animal ill-thrift is also not well defined, but the work on facial eczema, and the more recent indication that moulds may cause ryegrass staggers have led to an increase in the attention being given to pasture microflora in general.

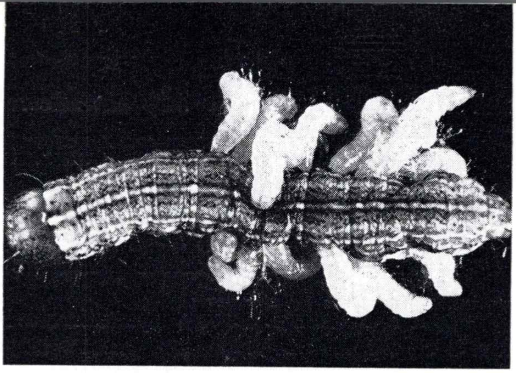
CONCLUSION

The major emphasis in the overall DSIR programme on pasture production can be summarised as follows:

1. Breeding and selection of pasture cultivars suited to optimal production in particular grasslands regions and breeding for single characters such as insect pest resistance, efficiency of fertiliser use, and nutritive quality.
2. Studying the management of pasture ecosystems in the major regions to achieve maximum production and utilisation of pasture through farming systems with low inputs of fertiliser, energy, and labour, and close matching of pasture production to animal requirements.
3. Clarifying of the nitrogen cycle in the various grassland regions, with the objectives of increasing the efficiency of biological inputs of nitrogen by symbiotic nitrogen fixation, reducing nitrogen losses from the system, and establishing when tactical inputs of fertiliser nitrogen should be made.
4. Increasing the efficiency of phosphate utilisation in pastures.
5. Reducing insect pest damage to pastures, especially by biological means such as the introduction of predators and the use of resistant plants, and widening the range of insects used to control weeds.

Lowland grasslands will face increasingly strong competition from horticultural and field crops, but there is a large potential for increasing production from lowland regions not used for other purposes. The realisation of these potentials on lowland and hill country is the greatest problem at present facing grassland research workers and farmers. The prospects for increasing pasture production in the various grassland regions are as challenging as at any period in the past.

Larvae of the parasite *Apanteles ruficrus* emerging through the body wall of a northern army caterpillar *(Pseudaletia separata).*



PASTURE WEEDS

The biological control of major weeds by insects is an area of increasing emphasis. Nodding thistle, first recorded in Otago in 1889, is now a major weed in many areas of New Zealand. In an attempt to combat it, a weevil, *Rhinocyllus conicus,* has been introduced from Canada and released at 5 sites in New Zealand. The weevil decreases thistle seed production because its larvae feed on the receptacle in the flowering heads, subtly cutting off nutrient supply to the seeds (see front cover illustration). Seed reduction of up to 85% has been recorded at the release sites, and it has been found that the weevil is able to search out and locate widely dispersed thistles. In addition, it attacks winged and slender thistles. Californian thistle is another troublesome weed, and two insects for its control are under study in quarantine in New Zealand.

PASTURE DISEASES

Plants grown for pasture are prone to attack by fungi and viruses. Diseases caused by the pathogens reduce the amount of herbage available for grazing, and in some instances directly affect animal health. The loss in pasture production caused by disease is in most cases not easily seen, and for this reason pasture diseases are usually not regarded by farmers as of great importance. Nevertheless, in some instances losses are known to be considerable and overall may well be serious. The most practical counter-measure that can be taken is to use plant varieties resistant to attack by pathogens. The work of Plant Diseases Division on pasture is broadly along the following lines: identification of diseases and of the pathogens that cause them; assessment of the importance to agriculture of each disease; and assistance to plant breeders in the selection of varieties resistant to specific diseases.

Crown rust is probably the most important fungus pathogen of New Zealand ryegrasses, causing substantial foliage loss during summer and autumn. A recent variety, Nui, was bred with some degree of resistance to crown rust, and work is at present being done to increase the level of rust resistance in this variety. Stripe rust was first identified, on cocksfoot, in New Zealand in 1975, and is now known to be widespread on this species throughout the country. Tests have shown that several Grasslands lines of cocksfoot have a high level of resistance to the disease.

Effects of disease are not always immediately obvious, e.g., prairie grass infected by the head smut fungus shows growth depression

Black beetle originates from South Africa, and as it has few enemies in New Zealand, a search is being made for controlling agents in its homeland. The most promising are predaceous beetles, and, in Northland, potential predator release sites have been established. As with all overseas introductions, strict quarantine procedures are observed.

A highly successful introduced parasite is the small wasp *Apanteles ruficrus* which parasitises northern armyworm. No major outbreaks of armyworm have been recorded in the few years since the parasite's release, and it is estimated that savings in pasture and crop production, and the cost of chemical control, are more than $1 million. The release of parasites of noctuid moth eggs (such as another wasp, *Telenomus remus,* which was specifically introduced for the potentially dangerous tropical armyworm, but which also parasitises other noctuids) applies added pressure to armyworm and greasy cutworm populations.

Insect pathogens

Entomology Division has been studying insect viruses in order to determine their value in pest control. An intensive search is being made within New Zealand to locate virus diseases of important pasture pests. No viruses of economic importance have been found in grass grub, but viruses isolated from porina and black beetle are under study. A protozoan parasite, *Adelina* sp., has also been found in black beetle.

Baculoviruses are the safest group for insect control, as they are only known to infect insects. Studies on the characterisation and replication of baculoviruses are being carried out on tropical armyworm which is ideally suited for mass rearing and gives high yields of virus.

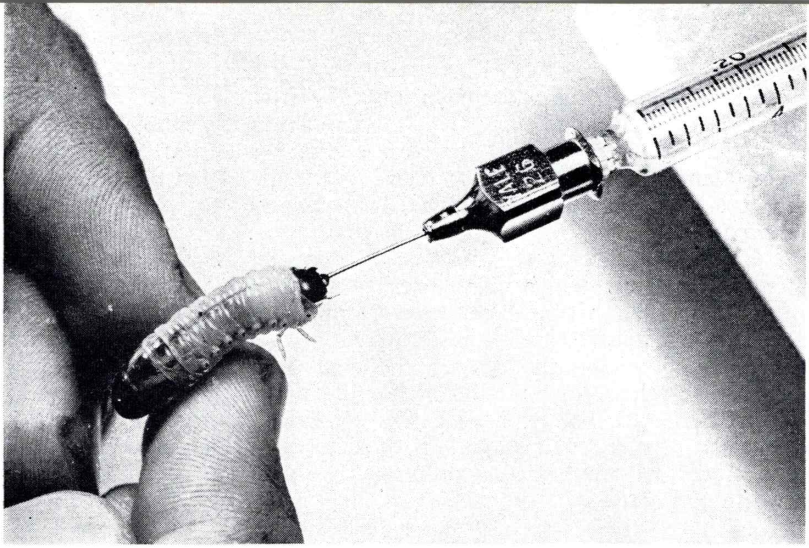
In general, the use of viruses for control of leaf feeding Lepidoptera appears to offer good prospects, but a lengthy period is required for safety testing before insect viruses can be used in the field.

Pasture nematodes

At least three species of nematodes cause serious decline of pasture legumes and lucerne; yield losses caused by nematodes in clover, ryegrass, and lucerne are being assessed by Soil Bureau. Nematodes also appear to be implicated in the general decline of clovers throughout the North Island. The effects on nematode populations of rotational cropping with, for example, chou moellier, and top-dressing with superphosphate are being investigated.

Apart from the use of nematicides in the initial establishment of lucerne stands, chemical control is not considered economic in pastures. Most research is therefore concentrated on the development of nematode-resistant varieties of clovers and lucerne (e.g. Washoe lucerne, resistant to stem nematode) in a collaborative project between Entomology, Grasslands and Crop Research Divisions.

Some nematodes control insects that cause pasture damage. Because of overseas achievements with members of the genus *Neoaplectana,* there has been a nationwide survey and two *Neoaplectana* species have been isolated, one from soil and one from a white fringed weevil larva.



A black beetle larva is being given a measured dose of *Lotus* plant extract via a blunt hypodermic needle eased into the gut. Using this technique it has been discovered that *Lotus* roots contain a powerful insect toxin for both black beetle and grass grubs, and larvae force-fed with concentrated extract die within 24 hours.

Plant resistance to pests

The discovery and exploitation of pasture plant species and varieties which are resistant to pasture pests are highly promising areas of research. Existing plants are being screened for pest resistance. Immediate practical results are the selection of the resistant plants lucerne and *Lotus pedunculatus,* which could be incorporated into farm programmes to alleviate the effect of grass grub and black beetle damage.

In the long term, it is necessary to know the mechanism and chemistry of resistance in order that plant breeders could incorporate resistance factors into susceptible varieties. So far, two strong feeding deterrents against grass grub and black beetle have been isolated from *Lotus*. In addition, a powerful toxin against both pests has been discovered in *Lotus* roots.

Biological control

The introduction of parasites and predators to control pasture pests offers an attractive, low cost alternative to the use of insecticides. Unfortunately grass grub and porina are native species (that have reached pest proportions because of man's creation of large areas of pasture) and have no known parasites or predators of any significance. Even extensive searches overseas have not enabled us to establish any introduced parasites.

Starlings are known to eat grass grubs. Experiments by Ecology Division showed that nest boxes are successful in attracting and increasing the number of starlings. However, many of the starlings in an experiment at Kereru disappeared after breeding and those that remained fed elsewhere. Rooks at Kereru removed a lot of grass grubs, but in searching for them in the topsoil caused serious damage to the pasture.

the highly active top layer of soil. Most only give one year's control. They depend on adequate rainfall shortly after application to ensure soil penetration. Also most are more directly toxic to vertebrates than organochlorines, and great care must be taken in their application. In addition the average cost of applying any insecticide is $40/ha and escalating rapidly. Research is now directed towards long-term solutions involving the minimum use of toxic chemicals and the exploitation of predators, parasites, and pathogens. Manipulation of management practices and use of pasture species resistant to pest attack are also under investigation.

The pests of major concern at present are grass grub, black beetle, porina, soldier fly, stem weevil, white fringed weevil, armyworm, and legume nematodes In addition, there is the constant threat from newly established species that are introduced accidentally from overseas. Two notable introductions over the past two years are the Sitona weevil and the blue-green lucerne aphid. Both attack lucerne and the latter has spread through a large part of the North Island and parts of the South Island. This is particularly disturbing as lucerne growing has been expanded in the last few years because the crop is resistant to attack by grass grub and black beetle.

In view of the seriousness of the situation, the research effort being applied to pasture pests is greater than that ever directed to the solution of any other agricultural problem in New Zealand, and involves the co-operative efforts of research workers from DSIR, the Ministry of Agriculture and Fisheries, and universities. A national co-ordinator of Government research on pasture pests has been appointed and research progress is reviewed annually. Several interim controls have resulted.

Within this co-ordinated research programme, Entomology Division has responsibility for basic innovative research into alternatives to chemical control and the Ministry of Agriculture and Fisheries Insect Control Group has a more field-oriented approach including the definition of the population dynamics of the various pasture pests as influenced by different agronomic systems and management methods.

Ecology and energetics of pasture pests

For each pest species, the provision of detailed information on population dynamics, life histories and the effect of physical factors in the environment is an essential basis for research on alternatives to chemical control. Entomology Division has built up an extensive insect collection and identification of pest species by specialists is an important service to workers on pest problems.

Studies on the effects of physical factors on insect dispersion and attack are also in progress. For example, for white fringed weevil dispersion is almost explosive in unfavourable host plant areas, but the weevils are much more sedentary in a preferred host area.

For grass grub, the physical ecology is now reasonably well known and present work is aimed at expressing in energy terms the role that this insect plays in the pasture ecosystem. The grass grub does not confine itself to any one pasture species and, because of inability to digest cellulose, it consumes more than if its digestive system were more efficient.

Large differences in the rates of live weight gain by sheep on common pasture could not be wholly explained by differences in voluntary intake by the grazing animals. Annual-type ryegrasses gave greater live weight gains than perennial-type ryegrasses, and white clover gave higher live weight gains whether fed alone or in association with the ryegrasses. Results from experiments showed feeding values* relative to Ruanui perennial ryegrass (100) were: Huia white clover 186, Maku lotus 174, Wairau lucerne 170, Paroa Italian ryegrass 161, Hamua red clover 151, Manawa ryegrass 148, Ariki ryegrass 111, and browntop 100 (in spring) and 86 (in autumn).

Herbage provides ruminants with energy from both sugars and fibre carbohydrates (cellulose, hemicellulose), nitrogen from ingested protein via rumen microbial protein, and essential minerals. Differences in cellulose levels between annual and perennial ryegrasses have been linked to differences in nutritive values. Perennial ryegrasses, with their higher levels of cellulose, are physically broken down more slowly in the rumen than annual ryegrasses. This in effect reduces the food intake of perennial varieties, and the longer time that they are retained in the rumen also results in less efficient utilisation of protein. With white clover, the high feeding value is partly due to increased food intake compared with ryegrasses, but also the nutritive value is higher because of increased utilisation of the feed due to the increased protein absorption which takes place in sheep fed white clover.

The grazing trials are complemented by indoor feeding experiments with sheep surgically modified to allow study of different parts of the digestive tract.

The digestive disorders which can occur in animals grazing high quality pastures may limit pasture quality improvement. The cause of bloat was shown to be a stable foam produced in the rumen after ingestion of lush legume feed, with plant protein as the main foaming agent. The Division developed the first effective control measure of spraying pastures with emulsified oils.

The long-term aims are to breed animals with a reduced tendency to bloat, and pastures containing bloat-inhibiting characteristics. In the short term, more efficient and cheaper detergent drenches are being developed.

Surveys by the New Zealand Dairy Board have shown that susceptibility to bloat is genetically inherited, and Applied Biochemistry Division, in collaboration with the Ministry of Agriculture and Fisheries, Ruakura, is investigating the differences between animals of high and low susceptibility.

Condensed tannins present in certain legumes such as sainfoin (*Onobrychis viciifolia*) and some *Lotus* varieties, complex with proteins in the rumen, preventing the degradation of the protein by rumen micro-organisms and inhibiting the foaming which is a characteristic of bloat.

The cause of ryegrass staggers in sheep and cattle is being investigated by Applied Biochemistry, Grasslands and Plant Diseases Divisions.

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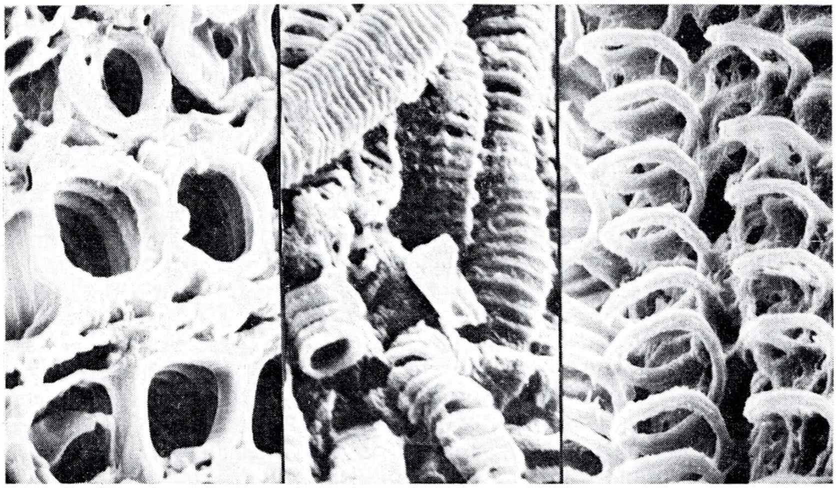
*Feeding value is defined in terms of animal production response to a herbage, and nutritive value is defined in terms of animal response per unit of feed intake.

Mycorrhiza

Beneficial associations (symbiosis) between endomycorrhiza (a group of root-inhabiting fungi) and a range of host plant species enable the host plant to obtain more soil nutrients than would otherwise be possible, largely by increasing the effective root zone. It is potentially important in many pasture legume species, which have poorer root hair development than most grasses.

Endomycorrhiza have increased growth of white clover under very low soil phosphate conditions, but their significance in soils with higher levels of phosphate remains to be evaluated. Probably the relationships of the endomycorrhiza with their hosts vary from mutual benefit to mild parasitism, depending on how much phosphorus the host can extract unassisted from the soil, and exclusion of the fungi from roots occurs only at high concentrations of available phosphorus.

Although widespread, endomycorrhizal spores are considerably less mobile than rhizobium, and potential could exist for inoculating legume-based pastures. Selection for efficiency in phosphorus absorption and translocation at higher available phosphorus levels may be necessary in order to exploit the mycorrhizal symbiosis for agriculture.



Scanning electron micrographs showing digestion of plant material in the sheep rumen. From left to right: cut section of lucerne stem showing xylem elements; xylem elements of partly digested stem after 2 hours in the rumen; degree of digestion after 32 hours in the rumen. Xylem elements that are originally cemented together are being released as the cementing substances are digested, and ultimately only the main fibres remain as material is digested from each xylem wall.

PASTURE QUALITY

Research is conducted by Applied Biochemistry Division into the factors in both plant and animal which affect the efficiency of conversion of plant material into animal products and the quality of those products.

shown to be a potential source of sulphur for pasture growth; the fraction utilised by plants is that occurring as water-soluble sulphate and pyrites rather than the organically bound sulphur.

Plant aspects

There is scope for improving the nutritional efficiency of pasture species, thereby reducing their fertiliser needs, because almost all New Zealand soils are phosphorus deficient, and increasing areas require sulphur and potassium fertilisers.

In grass-clover associations, clovers are recognised as the weaker competitors for those nutrients which most commonly limit pasture growth, and much of the fertiliser used in pastoral industry (mainly superphosphate) is required to obtain nitrogen, through stimulating clover growth and nitrogen fixation. In relation to fertiliser requirements of grasses, phosphorus and other nutrients have to be applied at luxury levels to provide adequately for the healthy growth of associated clovers. If the nutritional efficiency of clovers could be improved, significant fertiliser savings should result.

A research group, largely based on Palmerston North, is investigating principles involved in pasture plant nutrition, with particular interest in phosphorus and potassium. Lines under test include ecotypes gathered from appropriate environments throughout New Zealand and likely cultivars from overseas. A recent success was the identification of the superior performance of *Lotus* over white clover (both in terms of yield and nitrogen fixation) under conditions of soil phosphorus deficiency.

Experiments to describe the response curves of ryegrass and white clover, grown separately and in competition for scarce nutrients, should pinpoint those characteristics of grasses which give them their nutritional advantage. A range of pasture species is under study to describe differences in quantitative and morphological characteristics of roots, and to investigate relationships between these and the uptake of water and nutrients. e.g., root hair frequency and length, to phosphorus uptake by white clover.

Plot experiments have indicated that the low-growing clovers are less able to compete for limiting nutrients if management allows associated grasses to seriously shade them. Defoliation also affects phosphorus uptake by white clover, and in a farm-scale experiment the effects of grazing management on the phosphorus economy of developing hill pastures are being studied.

The poor recovery of fertiliser phosphorus by clovers relative to grasses may be related to their inability to obtain phosphorus from the thin upper layer of soil, where it accumulates with frequent top-dressing. Radioactive isotopes are being used to slow the uptake, movement, disposition, and relocation of phosphorus in white clover plants.

Scanning electron microscope techniques are to be used to determine anatomical features which may be relevant to salt movement both across and within the roots of pasture plants. In addition, the mechanics of salt absorption and translocation are being studied, e.g. data are being obtained for electrical potential differences within roots. Ryegrass varieties are being studied for differences in the ability of their root systems to transport absorbed salts to the shoots.

Phosphorus and other elements

Soil aspects

Surface movement of phosphorus and nitrogen under grazed pasture is being studied at Soil Bureau in order to gain an understanding of how slope, aspect, grazing regime, and rainfall intensity affect nutrient losses.

Continuing studies of the main soil types are providing information of both the available supply and reserves of other major nutrients essential for pasture growth, especially potassium, magnesium, and sulphur.

The pattern of available and reserve potassium in the major soil types has been defined, and soils known to be deficient or potentially deficient for pasture growth have been delineated.

The relationships between exchangeable and reserve magnesium and pasture production are less well understood. A satisfactory level in the herbage needs to be maintained so that hypomagnesaemia (grass tetany) in grazing animals is prevented. Research has indicated that an increase in the level of magnesium in the pasture herbage is often difficult to achieve because its uptake by plants depends not only on the levels of magnesium in the soil but also on the levels of other cations in the soil and on climatic factors. In a survey of exchangeable and reserve magnesium in New Zealand soils by Soil Bureau, the northern yellow-brown earths to podzol group, in which exchangeable and reserve magnesium have been depleted by the strong weathering and/or leaching influence of climate, and the yellow-brown pumice soils, which owe their low reserve magnesium to the low magnesium in their rhyolitic parent material, are potentially deficient.

Sulphur deficiency is widespread in New Zealand soils and sulphur needs of pastures are not always met by that supplied in superphosphate used to correct phosphate deficiency. Soils that are naturally well supplied with sulphur are generally acid, strongly weathered, and infertile soils with a high clay content; those that have a near neutral soil reaction and are of high natural fertility or of coarse texture are often poorly supplied with available sulphur.

A study of a climatic sequence of soils derived from mica schist, under tussock grassland, showed that the available sulphur supply to grasses increased with increasing rainfall and soil development. Under glasshouse conditions the "low fertility" grasses sweet vernal, Yorkshire fog, and browntop utilised adsorbed sulphur more effectively than did perennial ryegrass or white clover.

On a central yellow-brown earth to which sulphur-free phosphate was added, there was downward movement of absorbed sulphur, reducing its accessibility to pasture legumes. In field trials, *Lotus pedunculatus* grew better than lucerne, white clover or red clover, presumably because of the ability of its root system to obtain sulphur from the subsoil.

On sulphur-deficient soils where leaching of sulphate readily occurs, additional elemental sulphur is often used to 'fortify' the superphosphate applied. In field trials, on a sulphur-deficient gley podzol, iron pyrites was an effective fertiliser. In glasshouse trials, finely ground coal, which can contain appreciable amounts of sulphur, was

A convenient, robust technique is required for field surveys of nitrogen fixation in soils under pasture. The one used in a recently completed national survey entails injecting acetylene into incubation chambers containing plugs of soil.

with emphasis on the nitrogen economy of improved pastures, and largely unsuspected inefficiencies have been identified. These include inability of white clover to fix nitrogen under fertile conditions, and substantial nitrogen losses from grazed ecosystems

In collaboration with the Ministry of Agriculture and Fisheries, Grasslands Division have completed a national survey of nitrogen fixation (by field application of the acetylene reduction assay), changes in soil nitrogen, and nitrogen turnover through legume and non-legume herbage throughout the year over a range of climatic zones, soil types, and farming systems. The effects of various rates of applied nitrogen on the nitrogen economy of a standard ryegrass-white clover pasture are being assessed in an extension of this work.

Potential for use of fertiliser nitrogen

It is now generally recognised that the potential production of pastures is restricted by nitrogen deficiency, even at advanced stages of pasture development. Under some seasonal conditions the mobilisation of soil nitrogen falls well short of the potential of improved grass species to take up nitrogen and produce forage. When such conditions prevail, responses to fertiliser nitrogen can be expected. There is no evidence to support the year-round, extensive use of fertiliser nitrogen on pure grass swards, as is common overseas. However, the technology for relatively small, tactical inputs of fertiliser nitrogen as a supplement to legume-soil nitrogen, is now fairly well described. In individual farming situations, where cost/price relationships favour such a practice, such tactical applications are recommended.

Research in progress should help establish whether fertiliser nitrogen has a place in foreshortening the time required for pasture development under moist hill country conditions. A specific role for bag nitrogen has been established in the grass-seed industry and where the annual ryegrasses are deployed as forage crops during pasture renewal programmes.

scientists, and Grasslands and Applied Biochemistry scientists work on this subject.

Different legume species require different rhizobial strains for effective nodulation. Rhizobial strains for the common clovers and lucerne are selected and maintained at Plant Diseases Division and supplied routinely to manufacturers of legume seed inoculants. The rhizobia for all other legumes of importance or of research interest for New Zealand pastures are selected and maintained at Applied Biochemistry Division. Strains effective with a number of these species, e.g. *Lotus corniculatus*, sainfoin (*Onobrychis viciifolia*), and crown vetch (*Coronilla varia*) are not present in most New Zealand soils, and inoculation of the seed is essential.

Related studies concern the factors of both *Rhizobium* and host legumes which determine the effectiveness of the symbiosis. *Rhizobium* strains nodulating *Lotus* species are being used for the isolation of mutant strains resistant to different antibiotics and for the isolation of mutants having specific growth factor requirements (auxotrophic mutants). In many instances, antibiotic-resistance and auxotrophy are associated with loss of effectiveness, and research relates these mutations to the various stages in nodule development and to nodule effectiveness. The recently discovered ability of some *Rhizobium* strains to fix nitrogen outside of the host legume on a chemically defined medium is being used in these studies.

Lotus hybrid plants from different parent species requiring very different rhizobial strains for full effectiveness are being used in studies to elucidate some of the factors in the host plant which might be associated with nodule effectiveness. In these hybrids the inheritance of nitrogen fixation effectiveness is complex, but shows a considerable maternal component.

Bacteriophages (viruses) of rhizobia, which require susceptible rhizobia in order to survive in soil, are widespread in many New Zealand soils. Resistant mutants of *Rhizobium* occur, sometimes with decreased nitrogen-fixing ability. Susceptibility to bacteriophages, antibiotics resistance, and serology are used for the identification of *Rhizobium* isolates from soil and from nodules. This is an important part of research aimed at evaluating the possibility of increasing white clover production in fertile soils through seed inoculation, and defining the problems of successfully establishing new rhizobial strains in these soils.

Applied Biochemistry Division also studies the biochemistry of nitrogen fixation in legumes, since an understanding of the nodule system at both biochemical and genetic levels should provide greatest opportunities for manipulating the system. For example the maternal inheritance in *Lotus* hybrids mentioned earlier will only be understood when the biochemistry of nodule function has been defined more clearly. Current research has centred on determining the site of ammonia assimilation in legume nodules and in elucidating the role of biological membranes in nodule function.

Nitrogen movements in grazed ecosystems

The complex movements whereby clover nitrogen is made available to associated grasses, and indirectly to arable crops are being studied, grazing pressures are being assessed, and already (after one year) the mixture containing Nui perennial ryegrass and Pawera red clover with white clover is showing out as well as any.

Soil fertility and plant nutrition. — Problems associated with the growth of white clover in Southland pastures include differences in nitrogen mineralisation because of colder winters compared with other regions of New Zealand, and nutritional limitations. The seasonal patterns of nitrogen mineralisation are being established and the influence of soil pH on mineralisation is being assessed. In field and pot trials, the nutritional limitations of white clover, especially with lime, phosphate, and boron and zinc are being assessed.

Pasture management. — An integral part of the Division's research effort in Southland is to incorporate research findings into farming systems. The work has demonstrated that very high animal production can be obtained there under all-grass systems of farming, and in low-cost farming systems.

EFFICIENT MINERAL FERTILISATION OF PASTURES

A major aim in pasture research is to produce the maximum amount of herbage of acceptable composition for grazing animals, with the minimum inputs of costly mineral fertilisers. This is a complex task because of the mosaic of soil types, the number of mineral elements to be considered, and the differing behaviour of pasture species with respect to various elements. Three DSIR Divisions operate programmes concerning these soil/pasture mineral interactions—Soil Bureau and Grasslands and Applied Biochemistry Divisions—and there are many cross-links in their projects to the regional work of the Ministry of Agriculture and Fisheries and also to longer-term work on soil fertility and plant nutrition being undertaken by that Department.

Nitrogen

In comparison with other essential elements derived from soil, nitrogen is required in very substantial amounts. It is well established that the availability of soil nitrogen largely determines the botanical composition, distribution of yield, and stock carrying capacity of pastures.

While many developed countries have agricultural systems based on supplying vast amounts of fertiliser nitrogen, New Zealand farmers rely almost entirely on nitrogen fixation by symbiosis, the association for mutual benefit between host plants (legumes) and a soil-inhabiting bacterium (*Rhizobium* sp.). The host plants provide sustenance (sugars, etc.) to these micro-organisms, which inhabit nodules in their root systems, while the bacteria convert nitrogen gas from the air to organic forms, then useful to plants. In pastoral agriculture our most important legume is white clover (*Trifolium repens*), although other species including red clover (*T. pratense*), lucerne (*Medicago sativa*), subterranean clover (*T. subterraneum*), *Lotus* spp, and suckling clover (*T. dubium*) play a substantial part.

Growth and nitrogen fixation of pastoral legumes

Interest in the growth and nitrogen-fixing characteristics of pastoral legumes is, and will remain, a major preoccupation of grassland

SCIENTIFIC SERVICES FOR OTHER DEPARTMENTS*

One role of DSIR is to act as a centralised laboratory and provide scientific services to Government departments that need such services for their normal functions. These services may be classified under four broad headings:

Support of law and order
Services to the consumer
Inspection of Government stores purchases and
  Customs samples
Scientific assistance to Commissions of Inquiry

In doing this work DSIR does not itself exercise any regulatory function; but the results are sometime used for this purpose by the Government department for whom the work is done.

SUPPORT OF LAW AND ORDER

Police science

DSIR scientists may be asked to assist the Police by undertaking scientific examination of evidence in criminal investigations. The value of scientific evidence in Police investigations has been well established over recent decades, and the number of cases referred to DSIR has greatly increased. Few cases of serious crime are now prosecuted without substantiating scientific evidence.

Although the range of work is wide, and each investigation is unique, a number of established techniques are commonly used. One recent development has been grouping dried blood stains and other body fluids by identifying Rhesus factors, isoenzymes, and other specific blood properties in combination with the more conventional medical ABO and MN systems. By using these methods of identification, blood stains can be narrowed down routinely to groupings that include 4% of the population in the largest group, as opposed to up to 20% using only the ABO or MN classification systems.

The detection of fingerprints on cloth or other rough-textured surfaces has also been studied, because traditional techniques have not been satisfactory on these surfaces. Evidence is also given on identification of firearms, bullets, and cartridge cases; matching tool marks; studies of glass and paint flakes; identification of soils and material fibres; and the isolation and chemical analysis of flammable liquids or explosives. Samples available for examination may sometimes be so minute that very sensitive methods of analysis are required to show a link with the crime. Microscopic examination is well established, and other commonly used techniques are spark-source mass spectroscopy, electron-probe spectroscopy, and chromatography. A new technique called X-ray fluorescence will be increasingly applied to forensic cases, and has the advantage of being non-destructive.

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*This category of work was last reviewed in *DSIR Research 1971,* p.43.

Recently use has been made of an air-borne infra-red scanning camera in searches for missing persons, including those who may be buried in shallow graves. This equipment can be used to detect decomposing matter buried in the ground by the gentle heat it gives off.

Alcohol and driving

In May 1969 legislation came into effect which made it an offence for anyone driving a motor vehicle to have in their bloodstream more than 100 milligrams of alcohol per 100 millilitres of blood. Blood samples taken from drivers come to DSIR for analysis, and the results are recorded on certificates supplied to the enforcement authorities. If the proportions of alcohol found are greater than the legal limit, Court proceedings are instituted against the drivers concerned, and the DSIR scientist may be called on to give evidence. During 1975 over 12 000 blood samples were analysed by officers of Chemistry Division at Auckland, Gracefield, and Christchurch. An automated analytical facility designed to analyse up to 30 000 blood samples annually is now in operation at Gracefield, and this enables all blood alcohol samples to be analysed at one laboratory.

Illicit drugs

The number of drug cases submitted for analysis by Police and Customs Departments has doubled over the last two years, and is 10 times greater than it was 5 years ago. In 1975 the DSIR examined 1954 cases and found drugs in the following categories:

Cannabis	Lysergide	Heroin and morphine	Other narcotics	Prescription poisons
1520	88	88	29	179

Cannabis has become increasingly common in drug cases, but there has lately been an alarming increase in the number of cases involving the "hard drugs"—LSD, cocaine, and more recently heroin.

The forensic work has been intensified to detect drugs, often in very small quantities, and to cope with the vast increase in the case load. The Misuse of Drugs Act (1975) has authorised officers of DSIR to issue certificates of analysis that can be presented as Court evidence in illicit drug cases. Should the defendant wish to challenge the identification or the analysis, the DSIR scientist can be called to give oral evidence and answer cross-examination.

Police training

For scientific evidence to be used effectively in crime investigations, police officers have to be aware of what can be done by the scientist, and of the samples he will require.DSIR therefore helps with Police training, and scientists give lectures to all cadet and recruit courses, and more advanced technical lectures to detective courses. Specialised courses such as "homicide" or "scene of crime" courses include a scientist on the instruction staff. Lectures are also given on recognition of the different types of illicit drugs, and on the methods of analysis.

Coroners' inquests

Whenever a person dies in unknown or unexplained circumstances, it is the responsibility of the Coroner to establish the cause of death.

He will frequently request a pathologist to carry out an autopsy; and if the pathologist thinks that drugs or poisons might be involved, he sends specimens to DSIR for analysis. These normally include blood, the stomach and its contents, liver and urine. Results of analysis may confirm what appeared to be a suicide; or may exclude drugs and poisons and allow the conclusion that the death was due to natural causes. Occasionally a criminal action may be revealed. With some 1000 drugs and several hundred poisons now available, the toxicologist is continually re-assessing and expanding his techniques to keep abreast of change. Without this chemical investigation the likelihood of legal injustice and undetected murder would undoubtedly increase.

International law

There have been few cases of DSIR scientists becoming involved in international law. However, an interesting case arose in 1972 in connection with the exploration of space. Five large metal spheres were found in South Canterbury, after reports had been received of flaming red trails across the sky. These spheres were examined in the laboratory and identified as gas pressure vessels in a spacecraft that had disintegrated during re-entry to the earth's atmosphere. United Nations protocol requires that space debris of this type be returned to the owner; but efforts to establish ownership of these spheres have been unavailing, despite contact with the Russian and American Embassies. They have now been returned to the finders under normal "lost property" laws.

Women may be victims but are hardly ever culprits in accidents involving drivers who have been drinking; main offenders are young men, sometimes with a blood alcohol content under the statutory 100 mg/100 ml. Chemistry Division undertakes systematic analysis of blood samples taken from drivers.

Photo: Ministry of Transport

SERVICES TO THE CONSUMER

National standards

DSIR has statutory responsibility for maintaining New Zealand's national standards of physical quantities, such as length, mass, force, temperature, electrical quantities, frequency, etc. These standards are held by the Physics and Engineering Laboratory, and DSIR offers a calibration service for a wide range of physical equipment based on the standards. The metrication of physical quantities and the establishment of the Testing Laboratory Registration Council are making increased demands on standards. New Zealand industry is becoming more complex, and its export products are required to meet exacting specifications. These needs can be met by DSIR standards of measurement.

Time service

Provision of accurate time information (begun in 1869) is one of the earliest scientific services offered to the New Zealand public. Time signals are now broadcast by the New Zealand Broadcasting Corporation 20 times each day. They consist of 6 pips at 1-second intervals, the beginning of the last pip marking an exact minute. When a pip occurs on an hour, its length is doubled. A longer signal, for navigational and scientific purposes, with pips each second for 5 minutes, is broadcast daily, terminating at 11.00 a.m. New Zealand Standard Time. These time signals are normally held within one millisecond of Universal Time.

The introduction of New Zealand Daylight Time posed some problems for scientific services. Many meteorological observations taken during the initial period were not directly comparable with those taken in New Zealand Standard Time. A further complication arose from the designation of time zones around the world by internationally accepted indicator letters, that of the New Zealand Standard Time zone being M. No letter is available for a time 13 hours ahead of Universal Time (New Zealand Daylight Time), and some organisations added to the confusion by using the indicator M to mean either New Zealand Standard Time or New Zealand Daylight Time.

As the body responsible for the New Zealand Time Service, Geophysics Division was closely involved in formulating the legislation empowering the introduction of New Zealand Daylight Time. Geophysics Division is consulting world organisations in time-keeping and telecommunications about these problems, and will make any suggestions necessary to rationalise New Zealand's international time-keeping commitments.

Stores purchases

Much of the New Zealand consumer's purchasing is done privately, and it is difficult for him to exercise adequate quality control. However, when, as a taxpayer, he participates in the purchase of stores for Government departments, this unified purchase offers an opportunity to lay down specifications of quality, and to inspect the goods to ensure that they comply with specification. Stores purchased in this way are used by Government to provide a wide range of community services, such as health services, power generation, highway and bridge construction, communications and postal systems, and education.

DSIR acts as a testing and advisory agent to the Government Stores Board for a number of the larger purchases under period supply contracts, and helps prepare specifications to define the type and quality of material required. When the Board invites tenders, samples offered by manufacturers are tested for compliance with the specification, and as far as is possible the quality of the samples is assessed against the price to ensure that best value for money is obtained. A limited amount of quality surveillance is maintained during the course of the contract, to ensure that the standard of the tender sample is maintained.

When the characteristics of a product permit, quality is assessed by performance tests; but it is often necessary to define composition in some degree. Performance tests allow the manufacturer greater latitude in formulating his product, but there are serious problems in measuring performance effectively in the laboratory. This work involves cooperative studies with user departments. Examples of contract items which are tested are:

Paints.—The 13 items in the main paint contract cover interior and exterior building paints in both matt and gloss finishes, 3 types of anticorrosive primer, and a finishing paint for structural steel. Volume supplied under this contract totals over 300 000 litres annually, valued at about $280,000. There is a small separate contract covering 6 items of special paints required for naval use.

Lubricating oils and greases.—The 26 items in the oil contract include crankcase and transformer oils, industrial and marine oils of numerous types, and automotive specialities such as anti-freeze and brake fluids. Several viscosity grades of oil may be included in each item. The grease contract includes 6 items of which by far the largest is the multipurpose grease. The annual value of these contracts is $530,000 for lubricating oils and $23,500 for greases.

Polishes.—The 8 items in this contract cover floor, furniture, car, and metal polishes, to a total annual value of $87,000. Internal Affairs Department is cooperating with Chemistry Division in practical service trials on floor polishes under offer to the Government Stores Board with a view to correlating the results with laboratory performance tests.

Cleaning materials.—There are 3 separate contracts covering cleansers and detergents, soap flakes and powders, and soaps, with annual values respectively of $140,000, $146,000, and $136,000.

Apart from the direct benefits that accrue to the taxpayer from "best value for money", laboratory testing undoubtedly has widespread benefits for the private consumer. Stores Board prefers to buy standard proprietary lines, and testing of these tends to upgrade the overall level of quality. Manufacturers must improve their own quality control and testing procedures to obtain a share of Government business, and this is reflected in improved quality for the private consumer.

Sale of surplus stores

When surplus Government stores are sold (often by tender or at an auction), the best price can often be obtained if a full description of the material is available. Where the exact description of a material is lost or unknown, DSIR staff sometimes analyse the material to establish its uniformity and composition, thus ensuring that the best price is obtained for it.

Examination of customs samples

Excise duty is levied on many imported materials, and can differ according to composition of the material. DSIR staff analyse materials for the Customs Department so the correct classification can be established. In addition to analysis of a wide range of chemical products, these examinations are especially required in the case of alcoholic beverages. Imported spirits usually arrive at the dockside in concentrated form, often containing up to 120% proof spirit. The Food and Drug Regulations lay down a minimum proof content of 37.15%, so the imported concentrate is normally diluted before distribution to retailers. Measurement of the alcohol content establishes the degree of dilution that is permissible and the duty to be charged.

Checks are also made on the alcohol content of certain imported solvents, and on the quality of denaturing agents (such as pyridine) which are added to commercial alcohol in order to make it unpalatable as a drink.

SCIENTIFIC ASSISTANCE TO COMMISSIONS OF INQUIRY

Commissions of Inquiry, to which all citizens are invited to present relevant evidence or opinions, take many forms, ranging from Royal Commissions to specific investigations by the relevant Government Department (e.g., investigation of an aircraft crash by the Chief Inspector of Air Accidents in the Ministry of Transport). They often rely on DSIR to make the scientific evaluation.

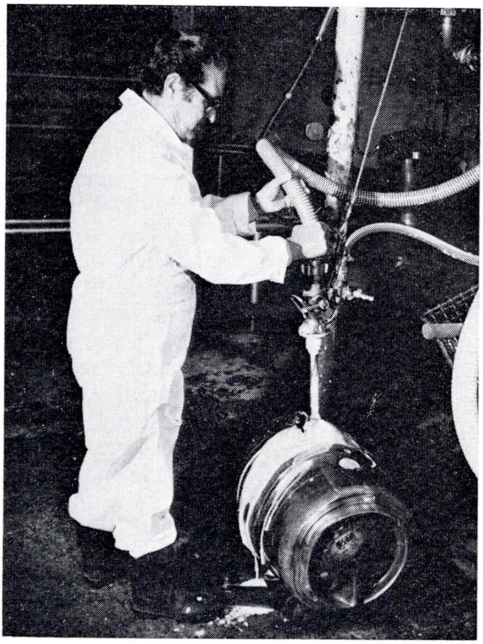
Exploding beer kegs

In 1963, and again in 1971, accidents occurred in which 2 people were killed when 80-litre aluminium beer kegs exploded at parties. At the time of each accident, the keg was connected to a carbon dioxide cylinder which was being used to provide a slight pressure (up to 35 kilopascals) in the keg to dispense the beer. The pressure within the carbon dioxide cylinder was 5000 kilopascals, and a pressure-reducing valve was being used to deliver low-pressure gas to the keg. An outlet pressure gauge was fitted to the reducing valve, designed to read pressures up to 400 kilopascals.

Tests carried out in the Metallurgy Section of Chemistry Division showed that the minimum bursting pressure of the kegs was about 1400 kilopascals. Since there was no evidence of defective fabrication in the burst kegs, it was apparent that the explosion had occurred because mismanagement of the pressure-reducing valve had allowed pressure in the kegs to build up to the maximum pressure available from the carbon dioxide cylinders.

Subsequent inquiries showed that there are no regulations governing the supply of keg-pressurising systems, nor of the operation of such systems by unqualified people. There is a compelling and demonstrable need for such regulations. Safe pressurising systems are simple to design and manufacture; provision need only be made for a regulator that

A few years ago, when it was more common for kegs of beer than bottles or cans to be supplied for parties, some accidents involved operation of the pressure dispenser. DSIR recommendations should ensure this type of accident does not recur.



properly limits the outlet pressure from a high-pressure cylinder, or for a safety valve in the keg. Manufacturers have been alerted to the dangers inherent in certain systems, and recommendations have been made to relevant State departments to ensure that this type of accident will not recur.

Parnell emergency

In recent years there has been a tremendous increase in the quantity of potentially hazardous chemicals carried by all forms of transport. Inevitably accidents occur, but in New Zealand until recently these have usually been minor, and of no particular concern to the general public. However, on 27 February 1973 an incident in Auckland affected many hundreds of residents and persons in the vicinity. Leakage of chemicals from drums created a fume nuisance of such magnitude that a Civil Defence emergency was declared. Subsequently a Commission of Inquiry was constituted to investigate all aspects of the emergency.

DSIR officers were called to the site at Parnell on the morning of the main spillage and thereafter were responsible for all technical aspects of the emergency treatment and clean-up procedures other than those of a medical nature.

The leaking chemical, labelled "Merphos", was herbicide in transit to Australia, where it was to be used as a cotton defoliant.

From the outset it was apparent that the fumes causing distress could not be the chemical as labelled, but that they were almost certainly from butyl mercaptan, one of the chemicals associated with manufacture or degradation of "Merphos". It was therefore recognised that "Merphos" was either undergoing chemical changes on exposure to the atmosphere, or that "Merphos" was a crude technical product containing significant concentrations of impurities. Subsequent laboratory research showed both to be the case. Initially, for the protection of emergency personnel in contact with the spillage, it was decided that the material should be regarded as one of the more toxic organophosphorus pesticides, which are related to "nerve gases".

To decontaminate the 3 spillage areas, the Department recommended the use of sodium hydroxide solution to hydrolyse the organophosphorus components of the spilled liquid, and to retain the volatile mercaptan component as the sodium salt. Samples of sodium hydroxide slurries from the treated sites were taken from time to time to the Chemistry Division Laboratory at Auckland and analysed to confirm the detoxication reaction.

A sample of "Merphos" from an undamaged drum was also analysed during the emergency. This analysis (and later studies) revealed that the "Merphos" contained a substantial quantity of an oxidation derivative from the main component of a more toxic nature, and that on exposure to the atmosphere an increasing amount of this toxic derivative was formed. The investigation also showed that 4% butyl mercaptan was present in the original "Merphos", and that oxidation produced further amounts. This butyl mercaptan rapidly evaporated on exposure to the atmosphere, and caused the principal effects observed at the spillage.

These factors, which were not deducible from the drum labels, were all adequately dealt with by the emergency measures adopted. The Commission of Inquiry concluded that the appropriate chemical, namely caustic soda, was used to decontaminate the "Merphos" spillage.

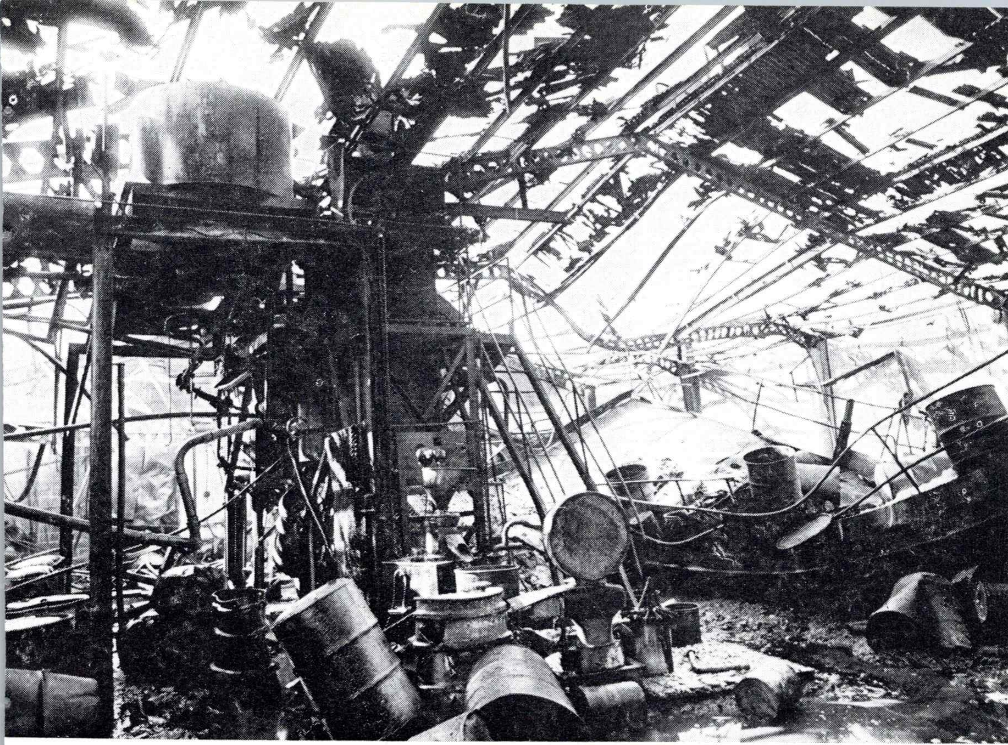
Ferris wheel tragedy, Palmerston North

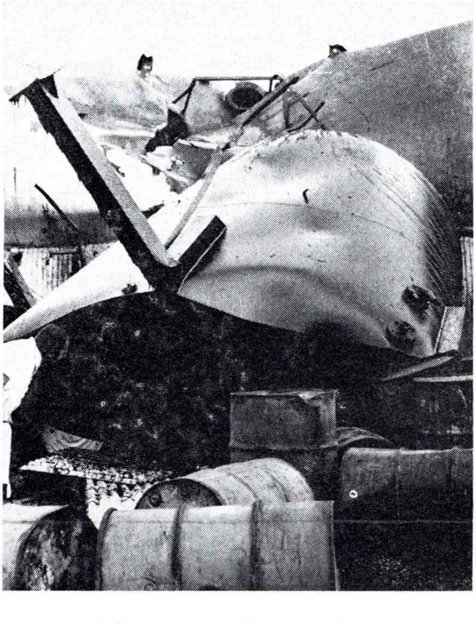
Three girls fell from a moving Ferris wheel during a carnival at Palmerston North in August 1973, and two of them died instantly. As a metallurgical failure was suspected, officers of DSIR were asked to examine the apparatus. It was apparent that the restraining leather strap had broken, and that the split pins holding the supporting bar, if present at all, had been quite ineffective in preventing this bar from springing from the socket in the sides of the chair. The chair had tipped, ejecting the girls out backwards; and the investigation showed that a small shift in the weight distribution of the occupants could cause this effect. In this unstable position there was considerable strain on the leather strap, and the breaking of this strap was a secondary cause of the accident.

The Commission of Inquiry accepted the view that the primary cause of the accident was instability of the chairs at the speed at which the Ferris wheel was being operated.

Explosion and fire at CMC Plant, Seaview

An explosion and fire occurred on 26 September 1974 in the waste oil distillation plant of CMC Ltd. at Seaview, and during the incident 5 men were fatally injured. It was reported that the distillation vessel (called the "drier") had ruptured and "rocketed" up through the roof





The explosion at Seaview, like similar accidents, was investigated by DSIR officers. Above: The fire damage. *Photo: Evening Post.* Right: The drier, ruptured by a steam explosion, which sprayed out burning oil causing the fire. *Photo: Wellington Fire Brigade, N.Z. Fire Service.*

of the building, and that the contents (about 7000 litres of hot oil) had been the source of the fire. Scientists from Chemistry Division were asked to assist the Commission of Inquiry determine the cause of the explosion.

The drier vessel was made of steel plate, and laboratory examination showed that it had ruptured at a circumferential weld at the base, probably because of a sudden rapid rise in internal pressure. This pressure build-up could have been caused by petrol vapour in the vessel, if a valve on the vapour outlet pipe had been closed; but this possibility was eliminated by showing that the distillate recovered from the plant matched the characteristics of the distillate obtained in the later stages of a laboratory-simulated drying-run. The batch of waste oil in the drier was known to have been heated on two previous occasions in the week before the explosion. However, owing to interruptions caused by minor failures of recently installed ancillary equipment, there was a possibility that this oil may not have been completely dried. Laboratory tests showed that water remaining in the oil tended to separate at the bottom of the vessel, and that the design of the plant did not permit this water to mix with the oil when the vessel was subsequently heated. Thus reheating could cause a steam explosion.

The Commission of Inquiry therefore concluded that the drier tank was ruptured by a steam explosion caused by the contact of settled water with the bulk of very hot oil.

Fire on Boeing at Christchurch Airport

On 28 April 1975 at Christchurch Airport, just after the passengers had been seated in a Boeing aircraft, loaders working in the front luggage compartment saw copious white fumes issuing from the open rear cargo compartment. These fumes rapidly increased in intensity and, as an acrid smell was detected in the passenger cabin, the passengers left the aircraft. At this stage the smoke cloud virtually concealed the aircraft fuselage. The emergency services were alerted and after several attempts the fire was extinguished.

The incident caused little damage to the aircraft, and neither passengers nor crew were injured, but the Minister of Civil Aviation requested the Chief Inspector of Air Accidents to investigate and report on the circumstances leading to the incident. The CIB were also involved at an early stage because a criminal act was suspected. Both authorities concerned submitted samples to Chemistry Division, and from an examination of these it was possible to reconstruct the incident.

It appeared that personal luggage containing methyl ethyl ketone peroxide "Super 60" had been loaded on the aircraft at Auckland, and the incident occurred when this peroxide leaked and contacted a contaminant on a jersey within the case. This caused a self-accelerating decomposition of the peroxide, and the chemical reaction was the source of the smoke-like fumes. Fortunately the peroxide fumes did not ignite, so the relatively minor fire within the compartment was totally confined by the "Stratoglas" lining of the cargo compartment.

The incident could have occurred at any time after the liquid leaked from the bottle, and if the reaction had occurred while the aircraft was airborne the possibility of an explosion could not be discounted.

DIRECTORY

LOCATION OF RESEARCH STATIONS

The main DSIR branches are clustered in the Auckland, Palmerston North, Lower Hutt–Wellington, and Lincoln–Christchurch areas.

Auckland: Auckland Industrial Development Division, Entomology Division, Plant Diseases Division, and substations and district offices of several other Divisions.

Palmerston North: Applied Biochemistry Division, Grasslands Division, Plant Physiology Division; the Dairy Research Institute and the Leather and Shoe Research Association; and substations and district offices of other Divisions.

Lower Hutt–Wellington: Head Office; Applied Mathematics Division, Chemistry Division, Ecology Division, Geological Survey, Geophysics Division, Institute of Nuclear Sciences, Oceanographic Institute, Physics and Engineering Laboratory, Soil Bureau, Science Information Division; and most of the Research Associations.

Lincoln–Christchurch: Antarctic Division, Botany Division, Christchurch Industrial Development Division, Crop Research Division, the Wheat Research Institute; the Wool Research Organisation; and substations and district offices of other Divisions.

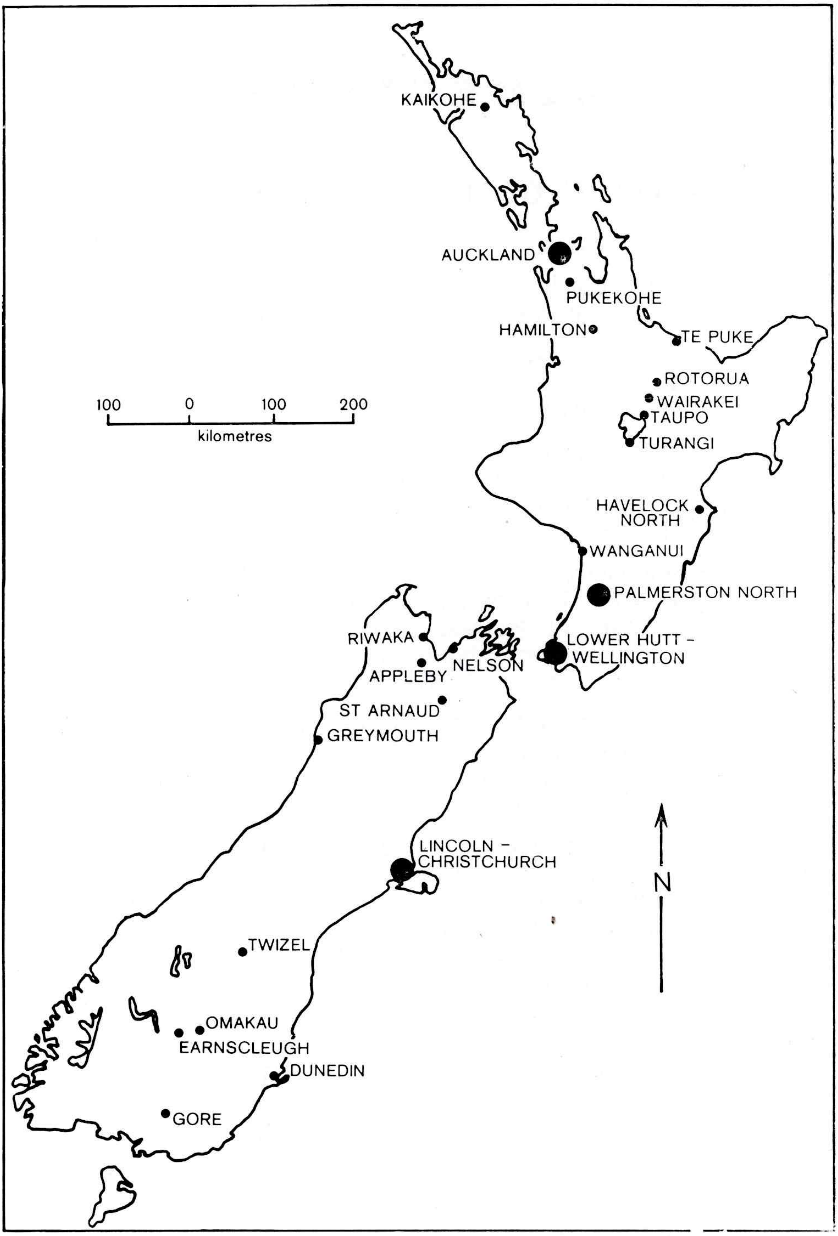
In addition to the main centres, most of the Divisions concerned with biological research have substations at which work related to particular environments is done, for example Grasslands Division has the most northerly substation within New Zealand (Kaikohe) and, with Crop Research Division, the most southerly one (Gore), Ecology Division has a freshwater substation at Taupo, and Plant Diseases Division has research orchards at Te Puke, Havelock North, Appleby, and Earnscleugh.

Divisions such as Geological Survey and Soil Bureau have district offices in several parts of New Zealand, and Physics and Engineering Laboratory maintains its auroral station at Lauder.

A liaison officer is stationed at the New Zealand High Commission in London.

In the Pacific, DSIR has a Plant Diseases Division research station on Rarotonga and observatories at Apia (Western Samoa), Rarotonga, Raoul Island, and Campbell Island.

In Antarctica, DSIR maintains a main base (Scott Base), Vanda Station, and a summer station at Cape Bird.



Distribution of DSIR research stations and substations.

SITE CONDITIONS AT THE MAIN CENTRES FOR BIOLOGICAL RESEARCH

MOUNT ALBERT RESEARCH CENTRE, AUCKLAND

Lat: 36° 54′ S. Long: 174° 44′ E. Alt (climatological station): 41 m.

Soil type: Basalt from volcanic cone of Mount Albert, overlying argillaceous sandstone; where sandstone is exposed the soil is podzolised.

Rainfall: Average 1356 mm per annum on 143 days, almost evenly distributed throughout the year, greatest from May to August and least from November to March.

Temperature: Mean maximum 19°C; mean minimum 11°C; mean 14.5°C. Days with ground frost: 17.

Hours of sunshine: 2102 (Albert Park).

PALMERSTON NORTH RESEARCH DIVISIONS

Lat: 41° 23′ S. Long: 175° 37′ E. Alt: 32 m.

Soil type: Manawatu silt loam.

Rainfall: Average 995 mm per annum on 180 days, distribution even, occasional late summer drought. Mean evaporation 787 mm.

Temperature: Mean maximum 16.6°C; mean minimum 8.3°C. Days with ground frost: 66.

Hours of sunshine: 1800.

SOIL BUREAU, LOWER HUTT

Lat: 41° 11′ S. Long: 174° 48′ E. Alt: 27.5-229 m.

Soil type: Taita hill soils from strongly weathered greywacke, and Wingate soils from loessial drift.

Rainfall: 1316 mm per annum on 163 days: distribution even with slight winter peak.

Temperature: Mean maximum 16.3°C; mean minimum 8.6°C. Days with ground frost: 29.

Hours of sunshine: 1789.

HOP AND TOBACCO RESEARCH STATIONS, RIWAKA

Lat: 41° 6′ S. Long: 172° 58′ E. Alt: 8 m.

Soil type: Riwaka silt loam.

Rainfall: 1372 mm per annum on 101 days; well distributed, but slightly heavier in winter months.

Temperature: Mean maximum 29.1°C; mean minimum 3.4°C; mean 12.3°C. Days with ground frost: 80.

Hours of sunshine: 2485.

LINCOLN RESEARCH DIVISIONS

Lat: 43° 38′ S. Long: 172° 48′ E.

Soil type: Alluvial silt loams.

Rainfall: 635 mm per annum on 125 days; distribution erratic, late spring droughts common. Mean evaporation (4 years) 955 mm per annum.

Temperature: Mean maximum 16.1°C; mean minimum 6.8°C; mean 11.6°C. Days with ground frost: 93.

Hours of sunshine: 2041.

DSIR SCIENTIFIC COLLECTIONS

The following scientific collections are held and maintained for research and reference by DSIR Divisions and grant-aided Research Associations.

BOTANICAL

General Herbarium	Botany Division, Lincoln Ecology Division, Lower Hutt
Herbage Species Herbarium	Grasslands Division, Palmerston North
Fungal Herbarium	Plant Diseases Division, Mount Albert, Auckland
Seed Collections	Grasslands Division, Palmerston North Crop Research Division, Lincoln Tobacco Research Station, Riwaka

INVERTEBRATES

Marine Invertebrates, Marine Benthos, Marine Plankton	Oceanographic Institute, Wellington
N.Z. Arthropod Fauna (non-marine, mainly insects)	Entomology Division, Mount Albert, Auckland
Freshwater Invertebrates	Ecology Division, Lower Hutt
Nematodes (National Nematode Collection)	Entomology Division, Mount Albert, Auckland
Insects	Ecology Division, Lower Hutt

VERTEBRATES

Rabbits, Hares, Rodents, Mustelids, and Wallabies	Ecology Division, Lower Hutt
Amphibians and Reptiles	Ecology Division, Lower Hutt

MICRO-ORGANISMS

N.Z. Reference Culture Collection of Micro-organisms	N.Z. Dairy Research Institute, Palmerston North
Soil, Plant, and Industrial Pathogens	Plant Diseases Division, Mount Albert, Auckland
Dairy Organisms and Phages	N.Z. Dairy Research Institute, Palmerston North
Meat Poisoning and Spoilage Organisms	Meat Industry Research Institute of N.Z. (Inc.)
Rumen Micro-organisms	Applied Biochemistry Division, Palmerston North
Rhizobium Strains	Applied Biochemistry Division, Palmerston North Plant Diseases Division, Mount Albert, Auckland

GEOLOGICAL AND SOIL

Petrological (a) Minerals (b) Rocks and thin sections	Geological Survey, Lower Hutt
Paleontological (a) Macrofossil (b) Microfossil (c) Palynological	Geological Survey, Lower Hutt
Core samples	Geological Survey, Lower Hutt
Soil Monoliths	Soil Bureau, Taita
Marine Surface Sediment Samples	Oceanographic Institute, Wellington
Marine Deep Water Sediment Cores	Oceanographic Institute, Wellington

HEAD OFFICE

Charles Fergusson State Building, Bowen Street, Wellington
POSTAL ADDRESS: Private Bag, Wellington 1 TELEPHONE: 729 979 Wellington
TELEGRAMS: RESEARCH Wellington TELEX: RESEARCH NZ3276

DIRECTOR-GENERAL: E. I. ROBERTSON, OBE, MSc *NZ*, PhD *Lond*, DIC, FRSNZ.

ASSISTANT DIRECTOR-GENERAL: G. W. Butler, MSc, FilDr *Lund*, FRSNZ.

Assisted by: E. W. Wright, MSc, PhD.
D. C. Isaacs, BAgrSc.

ASSISTANT DIRECTOR-GENERAL: D. Kear, BScEng, BSc, PhD, ARSM, FRSNZ, MAIMM.

Assisted by: D. Doyle, BSc, LLB.

ASSISTANT DIRECTOR-GENERAL: M. C. Probine, MSc, PhD, FInstP, FRSNZ.

Assisted by: L. P. J. Chapman, MSc, ACA.
L. Roberts.

Geothermal Co-ordinator: F. E. Studt, BSc, DIC, AMIMM.

Director of Administration: J. Gould.

Accountant: J. Russell, ACA, ACIS.

Technical Information Officer: W. Tait.

Counsellor (Scientific), London: R. W. Foster, CEng, MIMechE, MNZIE.

The Director-General, as Permanent Head of the Department, is directly responsible to the Minister of Science and Technology for implementing Government policy affecting DSIR, including assessment of research priorities, which is reflected in the provision of facilities, staff, and finance to branches. He is also an *ex officio* member of the National Research Advisory Council, established in 1963 to advise the Minister on co-ordination of the national scientific effort and selection and management of scientific programmes.

The three Assistant Directors-General advise the Director-General on specific fields of application of science and are responsible for appropriate groups of branches. Dr Butler is broadly responsible for agriculture and biology, human health, and the social sciences; Dr Kear is responsible for earth sciences, oceanography, minerals, and energy resources; Dr Probine is responsible for agricultural processing, forest products, and manufacturing, building and construction, transport and communications, and other scientific services.

The Director/Superintendent of any branch plans his programme of research to implement Department policy within the resources of staff and money allocated him. In the use of expensive equipment there is a considerable amount of collaboration between branches and between the Department and universities.

The Director of Administration organises the administrative and clerical service of Head Office and advises branches on administrative, staff, and clerical procedures.

Management aspects of the organisation of the Department are subdivided into science budget, Dr Robertson; personnel, Dr Butler; overseas liaison and technical assistance, Dr Kear; and buildings, large items of equipment, and computers, Dr Probine.

Through a continuing involvement with the work of the N.Z. Energy Research and Development Committee, the Geothermal Unit has become the focal point within DSIR for energy matters and co-ordinates the work of the several Divisions engaged in the field of geothermal energy research.

The Department maintains an officer on the staff of the New Zealand High Commission in London. The Counsellor (Scientific), seconded from DSIR, has a wide role in relation to New Zealand's scientific effort. This involves liaison on behalf of many New Zealand organisations, including Government departments, universities, and the manufacturing and commercial sectors; facilitating the exchange of scientific information; and assistance with visits of scientists between New Zealand, the United Kingdom, and other countries. The Office interviews applicants for scientific posts in New Zealand advertised in the United Kingdom and sends to appropriate employers information on scientists interested in employment in New Zealand.

ANTARCTIC DIVISION

Union Centre Building, 214A Oxford Terrace, Christchurch
POSTAL ADDRESS: P.O. Box 2110, Christchurch
TELEGRAMS: ANTARCTIC Christchurch TELEPHONE: 791 540 Christchurch

SUPERINTENDENT: R. B. Thomson, OBE.
STAFF: 3 science technicians and 25 supporting staff.

Antarctic Division, established in May 1959, co-ordinates and implements all New Zealand Antarctic activities. It is responsible for the execution and operation of Antarctic scientific activities approved by the Minister, and supervises approved Government and other expeditions to Antarctica. It maintains an information centre on Antarctic scientific research and exploration, and implements New Zealand Government policy on all other activities in Antarctica, including control of tourism. It ensures compliance with regulations in the Antarctic Act (1970) and internationally agreed measures for the conservation of Antarctic fauna and flora.

The Division's permanent strength in Christchurch is about 20, but temporary staff employed for service in Antarctica increases this number to approximately 50 during peak summer activity. A total of over 120 people (including worker visitors and university expeditions) are engaged annually in the New Zealand Antarctic Research Programme.

Antarctic Bases

Scott Base, Pram Point, Ross Island (77° 51′ 03″ S, 166° 45′ 45″ E, alt. 5 m). Scott Base, erected in January 1957 and manned year-round, consists of 10 buildings linked by covered ways. Normal winter population is 11, but during the summer it may be up to 50 at times. To alleviate the crowding and to provide more up-to-date facilities for scientists, a new base is being built nearby over the next five years. Construction of the first new building began in January 1977.

Vanda Station, Wright Valley (77° 14′ S, 166° 28′ E, alt. 30 m).

Cape Bird Station (Ross Island), situated near a large Adelie penguin rookery, is used during the summer by biologists from the University of Canterbury.

Scientific Programme

Each year the Government-appointed Ross Dependency Research Committee draws up a scientific programme from the proposals received (mainly from Government departments and universities). The programme goes to the Minister for approval and then to Antarctic Division for implementation.

The research at Scott Base and nearby Arrival Heights continues to provide valuable information in the fields of ionospherics, geomagnetism, earth currents, atmospheric physics, auroral physics, seismology, and meteorology. Infrasonic wave recording equipment installed last summer by the University of Alaska is now being operated by Scott Base staff.

Each summer field parties carry out an extensive programme of research in geology, geomorphology, geochemistry, volcanology, glaciology, hydrology, oceanography, and the biological sciences. Many smaller projects are often undertaken, such as sampling of atmospheric carbon dioxide, psychological studies of wintering staff, and aluminium corrosion studies.

New Zealand and the United States co-operate in providing logistic support to their respective programmes. This allows more specialists to participate in short-term summer projects.

Science technicians setting up a transmitting aerial in Windless Bight, 16 km north-east of Scott Base. The aerial is part of a project to monitor auroral infrasonic waves.

APPLIED BIOCHEMISTRY DIVISION

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: BIOCHEM Palmerston North TELEPHONE: 68 019 Palmerston North

DIRECTOR: R. W. Bailey, MSc, PhD *Birm,* DSc *Birm,* FRSNZ
Biophysics, Instrumentation, and Data Handling: K. I. Williamson, MSc *N.Z.*
Cell Biology: J. G. Robertson, MSc, PhD *Massey*
Digestive Physiology: C. S. W. Reid, MSc, PhD *Cantab*
Mammalian Biochemistry: T. E. Broad, BVSc, MSc, PhD *Cantab*
Microbiology: R. T. J. Clarke, MSc, PhD *Massey*
Monogastric Nutrition: E. L. Hove, BA, MSc, PhD *Wisc*
Nitrogen Fixation: R. M. Greenwood, MSc *NZ*
Organic Chemistry: G. B. Russell, BSc (Hons), PhD *Cantuar*
Plant Biochemistry: P. F. Reay, BSc (Hons), PhD *Cantuar*
Ruminant Nutrition and Metabolism: M. J. Ulyatt, MAgrSc, PhD *Massey*

SUBSTATION
LINCOLN LABORATORY, c/- Crop Research Division, J. D. Ferguson, BSc (Hons), PhD *Wales*

STAFF: 42 scientists, 45 science technicians, and 8 supporting staff.

Applied Biochemistry is concerned with the nutritional evaluation and acceptability of forages and human foodstuffs, and with some aspects of grassland and crop productivity, including photosynthesis and symbiotic nitrogen fixation. The core disciplines are biochemistry and nutrition, with supporting disciplines in ruminant physiology, microbiology, and the chemistry of natural products.

Current Projects

Mineral nutrition of plants and animals: nutrition and cycling of trace elements; chemical binding and availability of minerals in forages and foodstuffs.

Protein and nucleic acid biosynthesis: studies of regulation of protein and RNA synthesis in plant tissue.

Cellular development: changes in cells during differentiation; membrane biogenesis in legume nodules; characterisation of enzyme systems associated with nodule development and function.

Nitrogen fixation: biochemical, microbiological, and ultrastructural studies of symbiotic nitrogen fixation in legume root nodules; classification of rhizobial strains; studies on rhizobium phages and antibiotic resistance.

Plant carbohydrates: changes in composition of plant cell walls during development; mechanisms of biosynthesis of cell wall constituents; utilisation of sawdust and bark waste; investigations in fibre content and retting of linen flax.

Protein nutrition: investigation of alternative protein sources for livestock feeds and human foods (leaf protein concentrate, sweet lupin seed, and non-toxic rape seed meals); evaluation of nutritive quality of food and forage proteins.

Unusual plant constituents: plant phenolics especially tannins, cyanoglucosides and glucosinolates; oestrogenic substances in pastures; insect hormones and toxins in native plants; insect anti-feeding substances in plants; toxic compounds from pasture fungi.

Microbiology: microbiology of digestive tracts of ruminants, opossums and insects; scanning electron microscope studies of rumen wall and bacteria; microbial degradation of wastes and generation of methane.

Ruminant nutrition and metabolism: nutritive value of pasture plant strains; digestion and absorption of feed components in various regions of the ruminant gut; computer simulation of rumen digestive activities.

Digestive physiology: investigations of ruminant digestive system employing radiological, electronic, and chemical techniques; ruminant digestive disorders; excess fat in sheep.

Lipids: lipid composition of ruminants, rhizobia, and seeds; metabolism of dietary lipids in the ruminant; control of fat deposition in the ruminant.

Flavour: identification of mutton flavour components; investigation of effect of diet on flavour; gas chromatograph—mass spectrometer analysis of hop flavours.

Crop biochemistry: plant-insect relationships, including resistance to aphids, grass grub, and porina; abscisic acid effects on crop plants; agronomic and physiological factors affecting lupin seed yields; methods for screening plant populations for chemical characteristics.

Future Developments

The Division, often in collaboration with other organisations, will continue to concentrate mainly on aspects on New Zealand's primary industries, particularly innovative developments. Current projects in the initial stages of development include: microbial and enzymic conversion of agricultural wastes to energy, overfatness in sheep and lambs, utilisation of novel legumes, and the effects of secondary metabolites in plants used as animal feeds. Longer-term projects will evolve around the production of data on the nutritional composition of New Zealand foodstuffs and the investigation of enzymic and other aspects of crop processing.

To enable digestion in the rumen to be studied, some animals have a surgically implanted access tube, or cannula. Here, foam is pouring out of a bloated cow after removal of the bung from the cannula.

APPLIED MATHEMATICS DIVISION

7th Floor, Rankine Brown Building, Victoria University of Wellington
POSTAL ADDRESS: P.O. Box 1335, Wellington
TELEGRAMS: RESEARCH Wellington TELEPHONE: 727 855 Wellington

DIRECTOR: H. R. Thompson, PhD *Manch.*
Mathematical Statistics: J. H. Darwin, BA *Cantab,* PhD *Manch.*
Mathematical Physics: A. McNabb, BA *Cantab,* DSc *Vic.*
Operational Research: H. Barr, PhD *Toronto.*
Computer Software Development: B. K. Campbell, BSc.
Library: K. W. Summers, BA *Ill,* Dip NZLS.

SUBSTATIONS
AUCKLAND: c/- Mt Albert Research Centre. S. A. Tucker, MSc.
PALMERSTON NORTH: c/- Grasslands Division. V. J. Thomas, BA, PhD *Massey.*
LINCOLN: c/- Crop Research Division. E. Stevenson, BSc.

STAFF: 40 scientists, 4 science technicians, and 17 supporting staff.

Applied Mathematics Division provides a research and advisory service in those branches of applied mathematics that are of economic and scientific value to New Zealand. A central theoretical group in Wellington advances the study of applied mathematics and its application to biological and physical sciences, agriculture, industry, etc. An applied group, with members in Wellington and others attached to divisions at Auckland, Palmerston North, and Lincoln, copes with day-to-day problems of DSIR, and provides a service to other Government departments, universities, business, and industry. The Division has access, via minicomputers or terminals, to large Burroughs, IBM, and ICL computers.

Sections

Statistics: The section is concerned with design and analysis of experiments and surveys, and modelling the behaviour of scientific and other systems. It handles results of biological analyses, including population studies, and chemical and geophysical studies of the relationships between several variables. The main statistical techniques required are regression and analysis of variance, multivariate analysis (including numerical taxonomy), and the analysis of processes that develop in time and space and exhibit random as well as deterministic behaviour.

There is an increasing emphasis on social statistics in justice, housing, and social welfare. In such areas multivariate techniques, designed to reduce a mass of data to a small number of meaningful statistics, are important.

More industrial consulting work is being done. This is primarily concerned with quality control and design of experiments applied to a wide range of industries, mainly concrete, meat. and forest products.

Major theoretical work is currently on the power of rank tests, optimal stopping times for Markov chains. the fitting of mixtures of exponentials, and the asymptotic analysis of time series.

Mathematical physics: The section is primarily concerned with constructing and analysing mathematical models relevant to various scientific, engineering, and geophysical problems. This requires specialist knowledge of branches of continuum mechanics such as elasticity theory, fluid mechanics, and mass transport theory. Explicit solutions are rare, and approximation theory and allied techniques, such as asymptotic theory or perturbation theory, are important.

Most current research is directed towards understanding the reservoir mechanics of the Wairakei geothermal power project, and wider geophysical problems of the formation and behaviour of thermal regions in general. This research may give a better understanding of geothermal power resources available in New Zealand and more efficient means of exploiting them.

Operational research: Operational research is concerned with scientific collection and analysis of information to aid management decision-making. Questions of the best method of operation for a production line or of scheduling a fleet of vehicles can be considered. Planning decisions such as choosing between alternative future facilities to meet demand, where uncertainty and risk must be taken into account, can also be analysed. Usually the essentials of the system or operation are abstracted and expressed as a mathematical model. The model, rather than the real system, can then be investigated to find how it responds to different situations.

The section offers a consultant service on operational research, mathematical modelling, and systems analysis problems. This is available to manufacturing and processing industries and also to central and local Government departments. The section also advises on linear and non-linear optimisation problems, and on computer simulation.

Recent projects have included: methods for timetabling passenger vehicles, a linear programming investment model of a petrochemical complex, a model of the cash flows of a superannuation scheme, metropolitan public passenger transport modelling, energy modelling, and a location model for a new manufacturing facility.

Software development: The section has several main service and development activities: the provision of computing advice and assistance to other DSIR scientists; systems programming, i.e., the creation and maintenance of programmes which are an integral part of a computer system or are essential to its use by a particular class of user for applications; the provision of interactive terminal services; development and support of applications packages; data retrieval systems development and library automation.

The main systems project has been the provision of software to handle communications between the division's Hewlett Packard 2100A and Victoria University's Burroughs B6700. Other fields of interest are dynamic programming and the optimisation of computer operating system performance.

AUCKLAND INDUSTRIAL DEVELOPMENT DIVISION

Chandris House, 9-11 Albert Street, Auckland 1
POSTAL ADDRESS: P.O. Box 2225, Auckland
TELEGRAMS: AIDEL Auckland TELEPHONE: 34 116 Auckland

DIRECTOR: W. R. Beasley, CEng, MIMechE.

Administration Officer: M. R. Glennister.
Design Engineering and Product Development: B. H. Hodder, CEng, MIMechE.
Electronics and Acoustics: J. B. Cornwall, CEng, MIEE.
Engineering Dynamics and Stress Analysis: M. C. Smith, BSc, BE, PhD.
Liaison and Information: F. Puch, CEng, MIMechE.
Manufacturing and Management: J. B. Meikle, BE, PhD.
Metallurgy: P. E. Thomas, BSc(Hons).
Physics and Applied Heat: G. H. Palmer, MSc.

STAFF: 27 scientists, 35 science technicians, and 13 supporting staff.

The primary objective of the Division is to provide a scientific service to manufacturing and processing industry in the four general areas of mechanical engineering, metallurgy, physics, and electronics. A specialist group is active in medical and biological engineering.

Each section has a balanced programme of applied research, short-term investigations, and servicing. Information transfer is achieved by direct assistance; by liaison activities such as lectures, seminars, and conferences; and by production and distribution of reports, articles, and leaflets.

Current Projects

Agriculture: effect of storage conditions on kiwifruit, maize, potatoes, and other fruit and vegetables; design and testing of commercially sized storage facilities for produce; design and performance testing of maize-, lucerne-, and onion-drying installations; instrumentation to detect foetal death in sheep; measurement of fat thickness of sheep; and development of a system to combine sound absorption with requirements for hygiene in meatworks and food-processing plants.

Building and construction: evaluation of acoustic insulation of building-construction methods; advice on acoustic design of rooms; evaluation and reduction of building-construction and demolition noise; SANZ committee work on noise standards: calibration of soil- and clay-testing equipment; load capacity of fasteners for concrete; structural properties of roof, ceiling, wall, and floor sections; and evaluation of slip characteristics of different coatings on bolted structural joints.

Human health: monitoring the foetus in several patients simultaneously; development of apparatus for automatic epidural injections at set intervals, portable patient-borne recorder for monitoring heart beats over 24h, and apparatus for urine-flow measurement; environmental noise measurement and methods of assessment; and machinery-noise reduction in industry.

Manufacturing industry: Design — hydraulic-system components; evaluation of air-towel unit and time switches; assessing performance and efficiency of compressors, motors, and rotating machinery; design and testing of springs; design evaluation of automatic washing-machine gearbox; evaluation of automatic drilling machine; evaluation and testing of alloy wheels; assisting Industrial Design Council to evaluate locally manufactured products; design and quality control of vehicle components; design investigations into machines, products, and equipment in industry; evaluation of physical and mechanical properties of plastics, rubber, and synthetic engineering materials; evaluation of industrial applications of CO_2 laser; evaluation of noise characteristics of diesel and petrol engines; design of optimum silencers; and machinery-noise control. *Metallurgy and Metallurgical Services* — assistance to manufacturers in overcoming production problems relating to metal finishing, corrosion, engineering metallurgy, materials selection, heat treatment, welding, and casting; facilities for mechanical testing, metallographic examination, and heat treatment; chemical-analysis laboratory services; use of scanning-electron microscope and electron-beam microprobe analyser at the University of Auckland; investigating failures; plating-effluent treatment; quantitative measurement and evaluation of zinc die-casting variables (maximum velocity measurement); problems relating to lamellar tearing of heavy steel sections during fabrication by welding; and waste-recycling programme.

Manufacturing and Management — numerical-control advice and assistance with tape preparation; process-capability studies; value-engineering advice; metal-forming and metal-cutting advisory service; cutting-tool research and application to production problems; economic analysis of production operations with particular reference to machining and die-casting; systems advice on production-control methods, stores procedures, material handling, and production planning; operations-research techniques applied to manufacturing industries; plant-layout and group-technology implementation; quality control of manufacturing processes; quality-control and assurance-system advice; production-line gauging techniques; engineering-metrology services encompassing measuring components, tooling and gauges, calibrating industrial measuring instruments, and laser interferometry for the calibration of machine tools and machine-tool measuring systems; computer-aided design techniques; and industrial application of computers to the manufacturing environment. *Mechanical Engineering* — measurement of most engineering variables; consultancy service in vibration and stress analysis; pressure-vessel stress analysis; press load measurement; fatigue tests on special-purpose components; weighing yachts, launches, and large industrial units; evaluation of hospital and standard castors; transfer calibration of test equipment in industry; pressure testing (up to 40 000 psi or 275 MPa) of industrial components including prototypes; torsion testing of vehicle components; evaluation of invalid's wheelchair; calibration of torque-testing meters and pressure gauges; tests on mattresses and high-resilience foam plastics for mattresses; tests on abrasive papers; strength tests of large containers for aircraft; consultancy service in acoustics and noise control; vibration monitoring for machine condition; holographic interferometry for stress, vibration,

To protect a proposed carpark from the slip-stream of taxiing aircraft at Auckland International Airport, the Ministry of Works and Development built a sloped bank of earth at the edges of the carpark. Technical staff of Auckland Industrial Development Division are here seen preparing to measure wind-speeds caused by the slip-stream.

and non-destructive testing; truck-chassis design; and engineering design by the finite-element method. *Physics* — development of calibration facilities for temperature, humidity, and flow; and assessing performance of sound-measuring, noise-measuring, and recording instruments to TELARC standards.

Natural resources and environment: developing theory for geothermal fields; studying noise of aircraft, road vehicles, off-road vehicles, locomotives, and trains to establish statistical noise levels and directivity patterns under various operating conditions; and monitoring environmental noise to assist in Standards specification.

BOTANY DIVISION

Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: BOTANY Christchurch TELEPHONE: 8019 Halswell

DIRECTOR: E. J. Godley, MSc, PhD *Cantab.*, Hon. FLS, FRSNZ
ASSISTANT DIRECTOR: H. E. Connor, MSc.
Ecology and Vegetation Surveys: P. Wardle, MSc, PhD *Cantab.*, FRSNZ.
Palynology and Anatomy: N. T. Moar, MSc, PhD *Cantab.*, FLS.
Taxonomy: H. E. Connor, MSc.

SUBSTATIONS
Auckland: c/- Mount Albert Research Centre. A. E. Esler, MAgrSc.
Taita: c/- Soil Bureau. A. P. Druce, BE.
Nelson: DSIR, Private Bag, Nelson. G. N. Park, MSc, PhD *ANU.*
Dunedin: P.O. Box 5306, Dunedin. P. N. Johnson, BSc, PhD *Otago.*

STAFF: 26 scientists, 17 science technicians, and 7 supporting staff.

The main function of the Division is to study the plants in New Zealand and to describe and classify the native, naturalised, adventive, and horticultural elements of the flora. The description of vegetation, old or new, past or present ranks as a coequal objective. Correlated research is also carried out in genetics, cytology, anatomy, morphology, palynology and ecology.

To help achieve these major aims the Division houses the largest herbarium in the country and one of the better botanical libraries in Australasia. The Herbarium (International Code CHR, Keeper: Dr D. R. Given) contains about 275 000 specimens of seaweeds, lichens, mosses, liverworts, ferns, and higher plants. An experimental garden of 9 hectares is complementary to all studies.

Current Activities

Taxonomy: The process of recognition and description of all elements in the flora of New Zealand, native, naturalised, adventive or horticultural is a continuing one.

Two volumes of the *Flora of New Zealand* have been published, both dealing with native species; a third treating naturalised monocotyledonous plants has been finalised for publication. Work is advancing on a further volume about naturalised dicotyledons, and on another book concerned with all the grasses in this country.

General taxonomic studies are being made on lichens, on freshwater and marine algae, and on higher plants. Chemotaxonomy continues in the native genus *Carmichaelia.*

Visiting overseas specialists have worked on taxonomic revisions of the genus *Epilobium* and the freshwater charophytes.

Continuing services include: identification of plants especially weeds of crops, pastures, roadsides and waterways; advice on legislation concerning plants; recommendations for plant introduction; advice on poisonous plants; forensic botany.

Ecology and conservation: Few landscapes have been modified so extensively in such a short time as those of New Zealand. Over the last few decades, pressure of development and exploitation has come to bear heavily on the remaining lowland natural ecosystems, including grasslands, forests, and wetlands. It is therefore imperative to know what is adequately protected within existing reserves, and to identify further areas where nature protection should be the primary land use. To this end, Botany Division has been carrying out biological evaluations of the reserves administered by the Department of Lands and Survey, and of four of the National Parks, i.e. Tongariro, Egmont, Nelson Lakes, and Westland. Opportunities to propose new reserves arise where the Division is involved in their surveys, e.g. in the areas covered by the beech forest utilisation proposals, and in connection with environmental impact assessments. In another approach, rare and endangered species are being listed, and the adequacy of their protection appraised.

Pollen morphology and Quaternary botany: Clear, detailed descriptions of pollen grains are basic to identification in pollen analysis and as a tool for the taxonomist. The first may add precision to the reconstruction of vegetation and climate history; the second may reveal unexpected relationships or differences between plants. The preparation of a pollen atlas of native dicotyledonous plants is a current project designed to meet these criteria.

The greatest effort in pollen analysis is directed towards an understanding of vegetation and climate history during the last glaciation (Otiran) and the present interglaciation (Aranuian). Collaboration with specialists in other disciplines, e.g. geology, pedology, involved in Quaternary studies, is sought, and radiometric techniques are used wherever possible.

Reproductive biology: Studies in this field deal with the process leading to the production of seed (flowering times, pollination mechanisms, and fertilisation)as well as seed dispersal and germination. These are crucial stages in the life history of a plant. The breeding system influences the genetic architecture and variability of the next generation, while the size and extent of that generation is determined by seed production, dispersal, and germination, as well as the establishment of seedlings. Our present work involves observational and genetical studies of self-fertility, self-sterility, apomixis, male-sterility, dioecism, and sex-ratios in such genera as *Clematis, Cortaderia, Fuchsia, Mentha, Parahebe, Pseudowintera, Rosa,* and native umbellifers. Germination experiments on a wide range of species are carried out in a specially equipped laboratory. Recent publications include an analysis of the factors affecting sex-ratio in *Clematis gentianoides* in an attempt to explain the predominance of males in dioecious species of this genus; a comparison of the flowering times of hermaphrodite and female plants of *Gingidia decipiens* in natural populations; and a study of the longevity of seed in species of *Hebe.*

Structure and form: This includes a survey of native woods, and developmental studies of the peculiar juvenile forms of several native plants.

CHEMISTRY DIVISION

Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Petone
TELEGRAMS: CHEMDIV Petone TELEPHONE: 666 919 Wellington

DIRECTOR: A. J. Ellis, MSc, PhD, FRSNZ, FNZIC

Deputy Director: T. Marshall, BSc, BE, FNZIC, AOSM, AIME. Chemical Engineering, Industrial Chemistry, Process Development, Minerals Processing; Geochemistry; Geothermal, Inorganic Materials; Metals; Physical Chemistry; Spectroscopy.

Dominion Analyst: I. R. C. McDonald, MSc, FNZIC, ARIC, Applied Chemistry; Food; Forensic; Information; Instruments; Natural Products; Organic; Pharmaceuticals; Toxicology; Water; Auckland and Christchurch Branches.

ADMINISTRATION OFFICER: J. T. Milne.

DISTRICT LABORATORIES

AUCKLAND:
Broadcasting House, Durham Street West. Postal Address: P.O. Box 2224
Telegrams: CHEMDIV. Telephone 379 987
Government Analyst: D. F. Nelson MSc, D.Crim.(Cal), FNZIC
CHRISTCHURCH:
Government Buildings, Worcester Street. Postal Address: P.O. Box 2112
Telegrams: CHEMDIV. Telephone 65 419
Government Analyst: G. R. Scott MSc, FNZIC.

STAFF: 157 scientists, 76 science technicians, and 48 supporting staff.

The main functions of Chemistry Division are: to undertake long-term chemical, metallurgical, and chemical engineering research important to development of the resources and social needs of New Zealand, wherever possible anticipating future requirements for technical knowledge; to carry out investigations aimed at raising the efficiency of New Zealand industry, both private and State, and to promote new industries; to serve as a central laboratory for the chemical, metallurgical, and chemical engineering requirements of Government departments, undertaking specific work and co-operating in joint projects; and to encourage the growth of organisations, both Government and private, able to supply improved technical services to industry.

Current Projects

(A complete account is available in: Chemistry Division 1976 Handbook, *N.Z. DSIR Information Series No. 119*).

Human health: analysis of foods to ensure compliance with the Food and Drug Regulations (1973); analysis of drugs available on the New Zealand market; suitability and safety of containers for food and drugs; toxic elements and compounds; pesticide residues, calcium and phosphorus in the New Zealand diet; nutritional composition of special foods; dissolution of oral dosage forms of drugs; drug transport through membranes; in vivo comparisons of competing brands of drugs; drug stability trials; particle counts in parenteral solutions; honey quality; pottery glaze compositions; nitrate/nitrite levels in fruit and vegetables; persistence of lindane insecticide in pasture soils; production of experimental water-dispersible formulations of short-lived insecticides for grass-grub control.

Organic and natural products: structure of lignin and condensed tannins; colour and astringency of fruits and wines; yield and composition of vegetable seed oils; useful products from sea organisms; classification of native plants by chemical methods; production of lanolin; health aspects of solanum alkaloid levels in potatoes; photochemistry of rubber precursors; general aid to Government and industry in organic chemistry (analysis and spectroscopy).

Waters: investigation of water-supply quality and pollution incidents; analytical methods development and inter-laboratory testing (the CHEMAQUA programme); potable water treatment; trace metal concentrations in the Waikato River; chemistry of the Lower Hutt and North Canterbury Plains aquifers; causes of foam formation and discoloration in natural waters; land disposal of effluents; nutrient inputs and levels in the Pauatahanui Inlet (Pauatahanui Environmental Project); geochemistry of spring waters.

Forensic and toxicological science: identification of illicit drug seizures; examination of physical evidence submitted by the Police Department; analysis of post-mortem samples of human organs; grouping blood stains and other body fluids; identification of tool marks; specialist photography; therapeutic drug levels in blood; Transport Act samples for blood alcohol.

Geochemistry and geothermal studies: inorganic analysis of geologic materials; rock and mineral analyses; monitoring and elucidation of hydrothermal phenomena involved in geothermal power production; mechanisms of heavy metal and mineral transport and deposition in geothermal waters; spectrophotometry of high-temperature sulphur-containing solutions; investigation of volcanic fluids and gases; chemical engineering studies of two-phase flow; environmental geochemistry; utilisation of hot waters from geothermal and thermal power stations, e.g. for district heating.

Indusrial and mineral development: processing ironsand concentrates, and recovery of titanium and vanadium from ironsands; investigation of petrochemicals production; recovery and recycling of waste materials; advisory work on energy production and utilisation, petrol substitutes and waste heat utilisation; pollution abatement; silica and arsenic removal from geothermal water and calcium silicate production; co-operative research on production of gold and other minerals; extraction and processing of peat and lignite wax; extraction and processing of tall oil, resins, and waxes from bark, and solasodine from solanum; processing of lime oil; processing of agricultural products such as leaf protein and essential oils; fertiliser production; investigation of silicon ferroalloy production; recovery of lanolin from woolscour effluent; advisory work for the New Zealand electroplating industry; steel production.

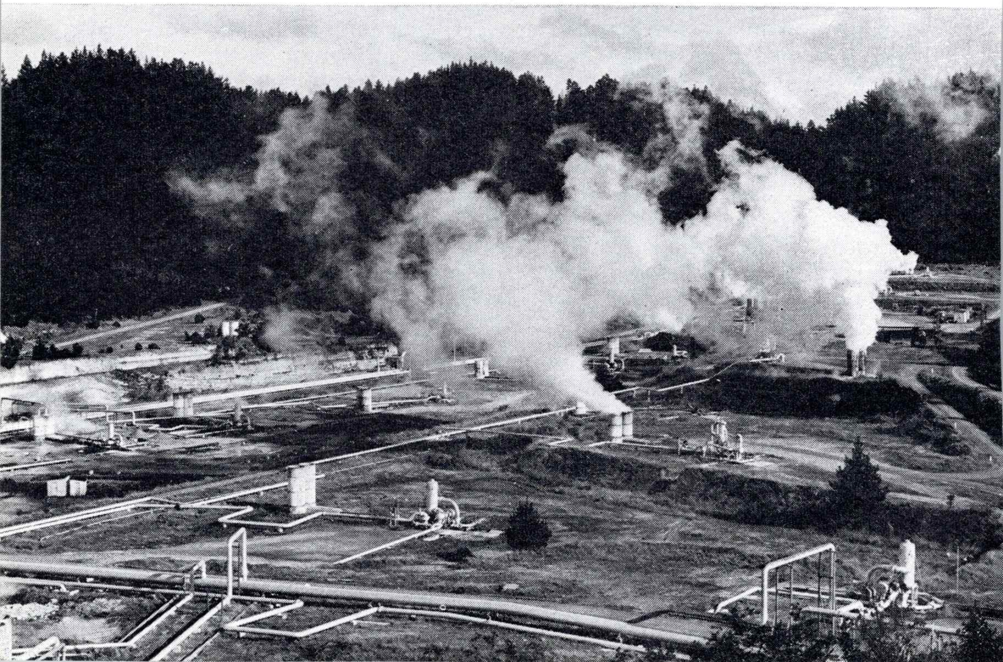
Consumer services: quality assurance of manufactured products; assessment of products for Government purchase contracts; preparation of specifications for paints, soaps, etc.; deterioration of car seat belts in sunlight and in service.

Building materials: protection of structural steel against corrosion; weather resistance of paint and varnish; performance of plastics, adhesives, and plastic-coated fabrics; cladding systems and attachment of exterior trim to high-rise buildings; investigations on cement and cement admixtures, concrete, pumice concrete, aggregates, and fly-ash concrete.

Metallurgy: corrosion, stress corrosion, and fatigue behaviour of metals in geothermal steam; non-destructive testing of metal components and structures to minimise failures in service; production of resin-coated silica for foundry shell moulding; advisory work on high-density baling of wool; quality of cans and canning methods for foodstuff containment; investigation of service failures of metal components and structures to help avoid recurrence of failures; advisory work for the New Zealand foundry industry.

Physical chemistry: crystal growth under controlled conditions; electron spin resonance and Mössbauer spectroscopic studies of minerals and metallo-organic compounds; crystallographic studies of drugs and natural organic compounds; tracing sources of toxic metals with emission spectroscopy; formation of activated carbon from waste bark and coal; computer modelling of geothermal downhole conditions; statistical analysis of blood alcohol analytical results.

The steam bores feeding Wairakei geothermal power station. Renewed emphasis is being given to use of geothermal resources.



CHRISTCHURCH INDUSTRIAL DEVELOPMENT DIVISION

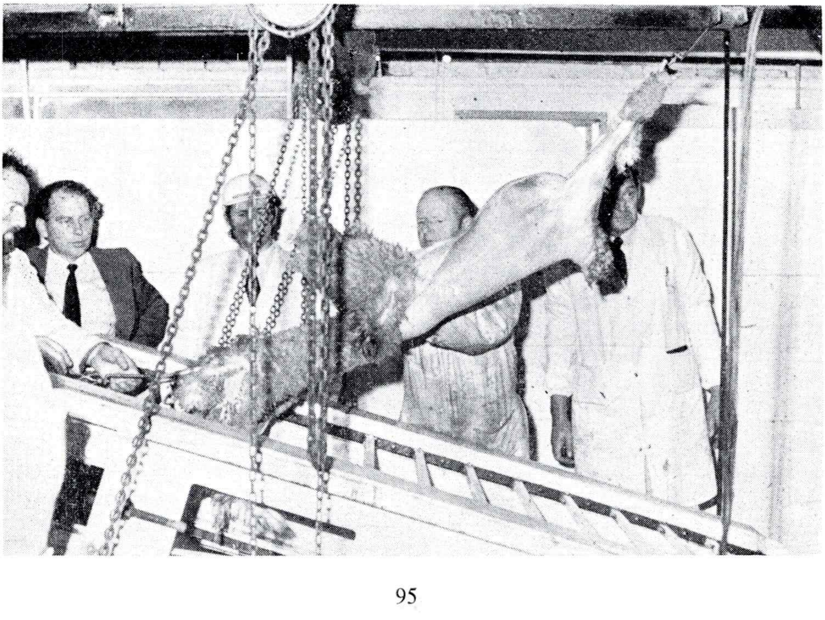
244 St Asaph Street, Christchurch
POSTAL ADDRESS: P.O. Box 1152, Christchurch
TELEGRAMS: RADEV Christchurch TELEPHONE: 62 369 Christchurch

DIRECTOR: T. H. Scott, BE Elec Mech, CEng, MIEE, MNZIE.
Standards Testing and Product Development: F. W. Seldon, BE, CEng, MIEE, MIMechE.
Electronics and Acoustics: E. D. Shipley, BSc.
Machine Development: A. A. J. Robertson, BE, AISE.
Liaison and Information: D. A. Hills, BSc, MNZIC, APRI.
Materials Science and Metallurgy: G. L. Allen, BScEng *Calif.*
Electrical Engineering: B. J. Halpin, BE(Hons)Elec, MNZIE.
Industrial Engineering: B. Donohue, BE(Hons)Mech.
Instrumentation: S. J. Hough.

STAFF: 11 scientists, 17 science technicians, and 12 supporting staff.

The Division has, for almost 30 years, provided a scientific research, development, and testing service for South Island industry, to assist with the development of products, reduction of production costs, and maintenance of high quality standards. The Division assists with testing, consulting, and applied research and development, and provides services not otherwise available to industry.

A skinning device for sheep and lamb carcasses under test during its development stages. Equipment under factory evaluation has resulted from co-operation between Christchurch Industrial Development Division and freezing works in the South Island. A suitable mechanical pelting machine will minimise bacterial contamination of the meat and improve productivity on the meat chains.



Current Projects

Materials science: wood engineering for sports equipment; lightweight concrete building panels; solar energy components and systems; water treatment (iron removal); horticultural glazing material; recycling of plastic waste; metallurgical services.

Standards testing and product development: development of further prototype helmets for topdressing pilots; standards testing of industrial safety belts, safety helmets (a second test rig allows testing to the Australian Standard) and electrical appliances (TELARC registered for this purpose); assistance to manufacturers seeking export markets in Australia.

Electronics and acoustics: tracking device for chamois to monitor movements; integral ear-pieces and acoustic design of agricultural pilot's helmet; metal detection in the meat industry; acoustic measurements and advisory work for industry, commerce, local bodies, and planning authorities.

Industrial engineering: measurement and monitoring of engineering variables such as pressure, temperature, flow characteristics, force, acceleration, velocity and displacement, weight, thickness, hardness, surface texture; materials and product testing for strength, stress distribution, and mechanical characteristics; laboratory calibration of load cells and accelerometers; dynamic balancing; analyses of stress and vibration for components and systems; general industrial trouble-shooting and advice in engineering and production problems; machine alignment.

The dynamic stress distribution for vehicle-side tow bar fittings is being determined; the results, which are related to safety, will be used in a standards specification to control manufacture and assembly.

Electrical engineering: product development and testing of 400 V transformers, miniature circuit breakers, fuses, and busbars; impulse, 50 Hz and radio interference testing of high-voltage transformers, insulators, and switchgear; assistance with development of a small wind-powered generator; general advice and assistance to industry on electrical problems; commissioning of 10 000 A, 440 V short-circuit testing station; planning 50 000 A, 440 V test station; assistance to university in planning extensions to h.v. laboratory.

Instrumentation: calibration, manufacture, and repair of instruments; instrumentation of wind tunnel for forestry research; advising on instruments and their application; photographic work.

Machine development: factory evaluation of a pelt-removing chain for freezing works which has been considerably modified from the original design; controlled-environment wind tunnel to study plant growth; design and development of a truck-mounted carpet cleaning machine; assistance with design of advertising display unit; assistance and advice on machine development in industry.

Liaison: preparation of publications and arranging articles in outside journals; contact with news media; improving liaison with South Island industry; ensuring that every inquirer is put in touch with someone who can answer his question, give direct advice, or undertake the necessary testing or research.

CROP RESEARCH DIVISION

Ellesmere Junction Road, Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: PLANTLAB Christchurch TELEPHONE: 8019 Halswell

DIRECTOR: H. C. Smith, MAgrSc, PhD *Cantab,* FNZIAS
Agrometeorology: J. W. Sturrock, BSc, DipAgr, PhD *Edin.*
Agronomy: D. J. G. Davies, DipAgr, DipAgrSc.
Cereals: G. M. Wright, MSc.
Crop Evaluation: A. D. Hall, BAgrSc, DipAgr.
Field Crops: T. P. Palmer, MAgrSc.
Fruit and Glasshouse: I. K. Lewis, MSc, PhD *Cant,* DipHortSc.
Genetics: P. A. Burnett, MAgrSc, PhD *Mnb.*
Potato-Food Technology: A. S. Bedi, BSc, MAgrSc, PhD *Edin.*
Process Crops: J. Lammerink, IrAgr *Wagen.*
Seed: J. P. Malcolm, MAgrSc.
Vegetables: H. J. Giesen, IrAgr *Wagen.*

SUBSTATIONS
OTARA: Crop Research Station, P.O. Box 61060. R. K. Bansal, MSc, NDK, PhD *Wis.*
PALMERSTON NORTH: Private Bag. J. M. McEwan, MSc, PhD *Mnb.*
GORE: Crop Research Station, Private Bag. D. S. C. Wright, MAgrSc, PhD *McGill.*

STAFF: 34 scientists, 35 technicians, and 32 supporting staff.

The Division is responsible for breeding improved cultivars of arable and horticultural crops to increase crop productivity, and conducts research in crop processing, food technology, genetics, plant breeding, and seed production.

Current Projects
Field crops: development of improved lucerne cultivars; development of hybrid sweetcorn and maize cultivars for different climates; breeding swedes for resistance to clubroot and rape for resistance to aphids; evaluation of new crop cultivars in comparison with existing local and overseas cultivars; maintenance of breeders' seed of all Government-certified cultivars of wheat, barley, oats, peas, kale, rape, and turnips and distribution to growers through appointed agents.
Industrial crops: breeding high-yielding, high-quality spring and autumn wheats; breeding high-yielding barley and oat cultivars for processing and feed grain; breeding peas for processing, and evaluating other legume crops; breeding rape, linseed, and sunflower varieties for oil; development of the peppermint crop for oil.
Environment: studies of shelter belts and crop reaction to wind; crop response to irrigation under different wind exposures; alteration of plant form and dry-matter distribution; weed control studies with high protein pulse crops including lupins and lentils; studies on the development of *Solanum* as a drug crop and its tolerance to herbicides; evaluation of cereals for winter forage production; evaluation of local and imported strains of tree nut crops for shelter, and timber and nut production; infra-red aerial photographic assessments of grass grub damage to pasture, stem nematode injury to lucerne, and extent of wind-blown timber from severe storms.

A tray of dried herbs being taken from a pilot-scale solar drier designed by the Physics Department, University of Canterbury. Crop Research Division staff are investigating production and processing of herbs.

Horticultural crops: improvement of vegetable crops for processing and for fresh market, including methods of seed production for F1 hybrid varieties; breeding potatoes for fresh market and for processing; evaluation of culinary herbs; breeding and selection of raspberries, strawberries, and apricots for improved flavour and increased yields.
Genetics: screening lucerne cultivars for resistance to blue-green aphid; screening cereal cultivars for resistance to barley yellow dwarf virus, mildew, leaf rust and aphids; ecology of aphid vectors in co-operation with Plant Diseases Division, Lincoln; evaluation of screening techniques for tolerance to *Verticillium* wilt in potatoes; evaluation of potato cultivars for resistance to potato cyst nematode, and determination of yield loss due to potato cyst nematode.

Activities

Barley and oat breeding: Three new cultivars which have recently been released, from crosses made in 1963 and 1964, outyield the present leading barley, Zephyr, by close to 10 per cent in Canterbury. Manapou and Mata have acceptable malting quality, and Mata has yielded well in the North Island. Kaniere, a feed grain, has considerably outyielded the others in preliminary trials in Nelson, South Otago, and Southland.

The Division has released its first brown oat, Omihi, as a replacement for Makuru in Canterbury; it is resistant to rusts and smuts and considerably higher in yield, but is not suitable for milling. The most promising milling oats from the Lincoln programme are sister selections of Omihi, but these have not yielded as well as Makuru in southern trials.

Navy beans: New Zealand produces only 10% (200 tonnes) of her annual requirement of navy beans, used in the manufacture of canned baked beans. Although a risky crop to grow because the seed is easily damaged by unfavourable weather during harvest, it can be very profitable. A reselection of the North American cultivar Sanilac has produced twice the yield of any lines previously grown and has replaced other navy beans grown in New Zealand.

ECOLOGY DIVISION

28 King's Crescent, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: ECOLOGY Lower Hutt TELEPHONE: 699 059 Wellington

DIRECTOR: J. A. Gibb, MA, DPhil *Oxon.*
Biological Survey and Birds in Agriculture: P. C. Bull, DSc.
Orongorongo Valley Field Station (forest ecology): R. E. Brockie, PhD.
Beech Forests and Reserve Management: R. H. Taylor.
Freshwater Ecology: E. White, PhD *Durham.*

SUBSTATIONS
TAITA: Laboratory, Animal House, and Workshop, c/- Soil Bureau, Private Bag, Lower Hutt. R. E. Brockie, PhD.
TAUPO: Freshwater Section, Ecology Division, P.O. Box 415, E. White, PhD.
HAVELOCK NORTH: Bird Research Laboratory, DSIR Research Orchard, Goddards Lane, T. P. G. Purchas, PhD.
NELSON: Ecology Division, DSIR, Private Bag. R. H. Taylor.

STAFF: 27 scientists, 21 science technicians, and 12 supporting staff.

The Division conducts research on factors affecting the distribution and numbers of animals; the effects of fauna on vegetation and in agriculture; and factors affecting the quality of freshwaters.

Emphasis is given to wildlife on agricultural land, including predation by starlings on pasture insects; to interactions between plants and animals in forest and other ecosystems not dominated by man; to ecological surveys of areas of special scientific importance; and to problems related to the management of parks and reserves, including offshore and subantarctic islands. Intensive research concerns the causes, effects, and control of the accelerated enrichment of freshwaters. The Division also advises on a wide range of environmental problems and on the auditing of environmental impact reports.

Current Projects

Biological survey: mapping the distribution of birds and other fauna; surveys of parks, reserves, and offshore islands; effects of browsing mammals on the vegetation, and of carnivores and rodents on native fauna; biology of stoats in National Parks; distribution of wild populations of domestic stock.

Birds on agricultural land: evaluation of bird damage to crops and methods of alleviating it; population biology of starlings and their predation on pasture insects; biology and control of rooks in Hawke's Bay.

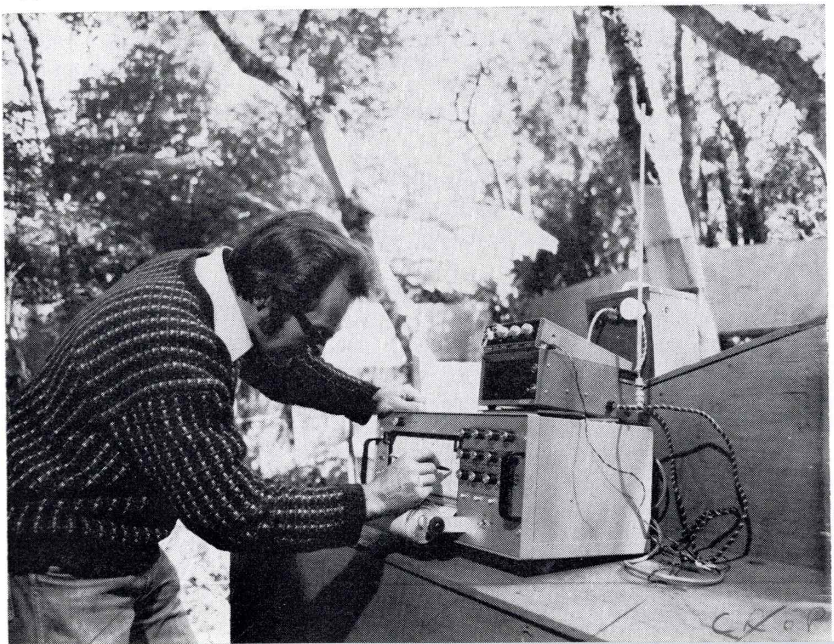
The erection of 850 nest boxes on pastoral land at Kereru in Hawke's Bay greatly increased the numbers of starlings breeding there, but did not intensify starling predation on the local grass grubs because most of the birds reared in the boxes left the neighbourhood shortly after the breeding season. Future research will investigate where these starlings spend the winter and what becomes of them. No young starling reared at Kereru has yet been reported in orchards or vineyards elsewhere in Hawke's Bay.

Ecology of native forests—Orongorongo Valley Field Station: studies of vegetational changes emphasising the effects of browsing mammals; phenology of trees and shrubs; litter-fall and seed production; effects of variations in seed production on rodent numbers; ecology of wild cats, stoats, and goats; population ecology, food, nutrition, and activity of opossums; defoliation of rata by opossums and insects; ecology and seasonal fluctuations of litter invertebrates; population ecology and foods of native birds. Special attention is devoted to the rate at which the composition of the forest is changing, especially with the death of rata as a result of browsing by opossums.

Nelson substation: numbers, movements and hunting pressure on red deer in Nelson Lakes district; effects of beech forest management on birds and mammals; methods of counting birds in forests; bird numbers related to habitat, food supply, and predators; requirements for biological reserves. An attempt is being made to measure the extent to which lowland forest, already much reduced in area, serves as a winter refuge for birds frequenting forest at higher altitudes in summer.

Freshwater research: measurements of aquatic plant nutrients, especially nitrogen and phosphorus, including those discharged from septic tanks on the shore of L. Taupo, and those released from the sediments of L. Rotorua during calm weather in summer; chemical run-off from catchments under various kinds of land use; groundwater discharges into Lakes Taupo and Rotorua; bioassay technology; identification of nutrients limiting plant growth; uptake of plant nutrients by stream beds; and the contribution of ultraplankton to the primary productivity of oligotrophic lakes.

Tuning in to opossums. An automatic chart recorder plots the activity of radio-tagged opossums in the bush-clad Orongorongo Valley.



ENTOMOLOGY DIVISION

120 Mount Albert Road, Auckland 3
POSTAL ADDRESS: Mt Albert Research Centre, Private Bag, Auckland
TELEGRAMS: ENTLAB Auckland TELEPHONE: 861 059 Auckland

DIRECTOR: J. M. Hoy, DSc
Biological Control: E. W. Valentine, BAgrSc, DIC.
Ecology: C. H. Wearing, PhD *Lond,* DIC.
Nematology (joint section with Plant Diseases Division): F. H. Wood, PhD
Physiology: O. R. W. Sutherland, PhD *Cantab.*
Rearing: P. Singh, AIARI, PhD *New Delhi.*
Systematics: J. C. Watt, DPhil *Oxon.*
Virology: J. F. Longworth, MSc.

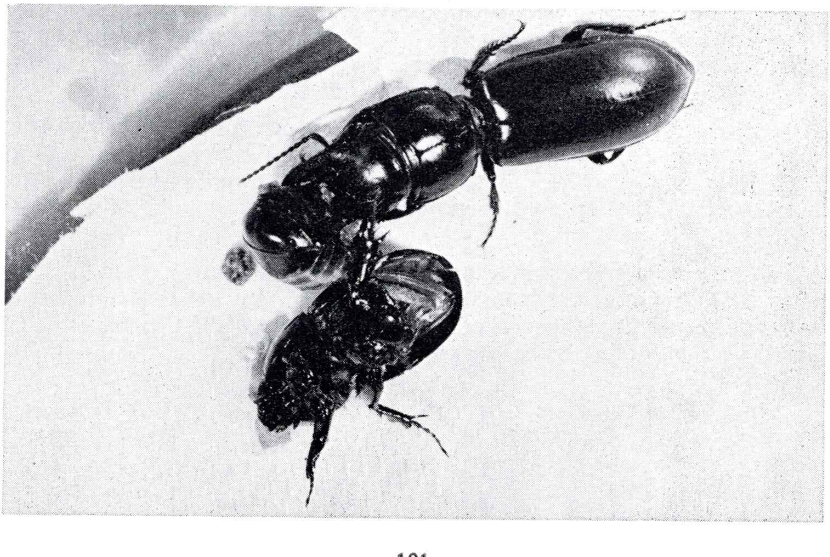
SUBSTATIONS
LINCOLN: c/- Crop Research Division, J. A. K. Farrell, PhD *Reading,* DIC.
PALMERSTON NORTH: c/- Grasslands Division, M. J. Esson, BSc.

STAFF: 37 scientists, 37 science technicians and 9 supporting staff.

The Division conducts research on insects, mites, and plant nematodes, with emphasis on those species of economic importance in agriculture and horticulture. Research is oriented towards the development of control methods involving minimum use of toxic chemicals and the exploitation of beneficial species.

Current Projects
Biological control: introduction of parasites of noctuid caterpillars; search for controlling agents of black beetle; surveys for predator and

The predatory beetle *Scarites* is here seen attacking and eating an adult black beetle. Both the larvae and adults of *Scarites* will prey on larvae and adults of black beetle. The introduction of *Scarites* from South Africa is being considered to assist in the control of black beetle in New Zealand.



parasite establishment; control of nodding and Californian thistle by phytophagous insects; use of insecticide-resistant predaceous mites; predators and parasites of aphids; legume pollination.

Ecology: resistance of pasture plants to grass grub, porina, clover case bearer, stem weevil, and lucerne aphid; energetics of a grass grub–pasture system; hill country entomology; ecological studies of crop aphids, brassica pests, codling moth, San Jose scale, greedy scale, leafrollers, sitona, flores, and white-fringed weevils; insecticides for brassica pests; effect of insecticides and fungicides on earthworms; pesticide resistance of mealy bug, leafroller, and European red mite; control of Chinese gooseberry pests; nationwide leafroller survey; integrated control of apple pests; integrated mite control; use of pheromones.

Systematics: survey, identification, classification, and characterisation of the New Zealand terrestrial and freshwater arthropod fauna; association of immature stages with adults; life histories; relationships with host plants; insular faunas including Kermadecs and subantarctic islands; biogeography; comparative faunal surveys; conservation; epigean and phreatic faunas; arthropods of Cook Islands, Niue, Tonga, and Samoa.

Nematology: studies on stem eelworm in lucerne; root-knot nematodes in clover, lucerne, and carrots; dagger nematode in apricots; lesion nematode in apples and cherries; life history, population dynamics, yield effects, and control of potato cyst nematode; screening white clover and lucerne for resistance to nematodes; role of nematodes in "pasture decline" syndrome; environmental factors affecting nematodes; nematode diseases of Cook Islands; insect parasitic nematodes as potential controlling agents; taxonomy of cyst-forming nematodes.

Physiology: behaviour of pasture and crop pests with emphasis on the role of chemical attractants, repellents, feeding stimulants, and deterrents; isolation and identification of chemical factors conferring resistance to grass grub and black beetle; insect defence secretions; chemistry of pheromones of horticultural pests and use in survey and control programmes; insect chemoreceptors; electrophysiology of behavioural responses of grass grub, codling moth, and leafrollers.

Rearing: artificial diets and mass-production for economically important insects; nutritional physiology and diseases; aseptic rearing; role of antibiotics, antimicrobial food additives, and antimetabolites in diets; hormonal physiology and investigations into entomologically active compounds from plants.

Virology: characterisation and identification of New Zealand's more important lepidopteran baculoviruses with a view to evaluating their safety; survey of pathogens of major pasture pests, with emphasis on black beetle; studies on insect picornaviruses.

GEOLOGICAL SURVEY

State Fire Building, Andrews Avenue, Lower Hutt
POSTAL ADDRESS: P.O. Box 30 368, Lower Hutt
TELEGRAMS: GEOLOGICAL Lower Hutt   TELEPHONE: 699 059 Wellington

DIRECTOR: R. P. Suggate, MA *Oxon*, DSc, FRSNZ

Project Geology: G. W. Grindley, MSc, DSc, FRSNZ.
Paleontology: N. de B. Hornibrook, MSc, DSc, FRSNZ: G. R. Stevens, MSc PhD *Cantab.*
Technical Liaison and Information: S. N. Beatus.
Petrology: W. A. Watters, MSc, PhD *Cantab.*
Engineering Geology: L. E. Oborn, AOSM.
Economic Geology: B. N. Thompson, MSc.
Earth Deformation Studies: G. J. Lensen.
Petroleum: H. R. Katz, PhD *Zurich.*

DISTRICT OFFICES
AUCKLAND: Otara Research Station, Otara Road, Papatoetoe, P.O. Box 61012, Otara. Telephone: 49 529 Papatoetoe. J. C. Schofield, MSc.
ROTORUA: NZBC Building, P.O. Box 499. Telephone: 82 189 Rotorua. I. A. Nairn, MSc.
TURANGI: c/- Ministry of Works, Private Bag. Telephone: 7799 Turangi. B. D. Hegan, MSc.
HUNTLY: P.O. Box 18. Telephone: 88 140 Huntly. A. M. Sherwood, MPhil.
WELLINGTON: P.O. Box 30 368, Lower Hutt. Telephone: 699 059 Wellington. T. L. Grant-Taylor, MSc.
NELSON: Private Bag. Telephone: 81 082, 82 319 Nelson. M. R. Johnston, BSc (Hons), PhD.
CHRISTCHURCH: Geology Building, University of Canterbury, Private Bag. Telephone: 71 649 Christchurch. G. Warren, MSc.
Sedimentation Laboratory: P. B. Andrews, PhD*Tex.* E
TWIZEL: c/- Ministry of Works, Private Bag. Telephone 809 Twizel. D. F. MacFarlane, MAppSc.
CROMWELL: P.O. Box 64. Telephone: 421 Cromwell. R. Thomson, BE.
DUNEDIN: P.O. Bldg, Moray Place, P.O. Box 5342. Telephone: 77 722 Dunedin. I. C. McKellar, MSc.

STAFF: 75 scientists, 37 science technicians, and 22 supporting staff.

The work of the Geological Survey covers all major fields of basic geology. Because there are few geological consultants in New Zealand, economic geology constitutes about 50% of the Survey's work. It acts as geological consultant to Government departments, local authorities, and many private companies and individuals.

The Survey issues geological maps, reports, bulletins, and scientific papers. These, with the extensive collections of rocks, minerals, and fossils in Lower Hutt, form an invaluable store of knowledge about the geology and mineral resources of New Zealand.

Current Projects

Regional geology: regional geological mapping, for publication at scales of 1:63 360 and 1:50 000 (metric), particularly in Auckland, Wairarapa, Nelson, and Otago, emphasis now being placed on sedimentary basins with rocks of Cretaceous to Pleistocene age; production of maps at 1:25 000 for industrial and groundwater uses around Auckland and Christchurch; final proof reading of Volumes I and II of *The Geology of New Zealand*, recording 100 years of geological observation.
Paleontology: basic systematic study of fossils and their occurrences in New Zealand rocks; regional studies leading to ecological, climatic, and

geographical inferences in geological history; stratigraphic control for oil and coal drilling by determining ages of microscopic fossils in drill cuttings; computerisation of fossil records, including their occurrence in all areas and rock formations of New Zealand; studies of Pliocene limestones in Hawke's Bay and Cretaceous rocks of east coast North Island in relation to petroleum potential; geological comparisons between New Zealand, Australia, Antarctica, and New Caledonia.

Sedimentology: studies of sand and gravel on modern beaches, rivers, and dunes; similar study of fossil sediment in New Zealand rocks, particularly greywacke and sandstone-mudstone; application of these techniques to regional mapping and applied geology.

Mineral and energy resources: regional geological mapping of mineralised areas in Coromandel and north-west Nelson; studies of specific mineral deposits: metallic minerals, non-metallic minerals (including limestone, silica sand, lump silica, and a search for bentonite in Indonesia); water resources (principally Northland, Nelson, and Canterbury Plains); coal exploration (Waikato, Westland. and Southland); petroleum studies (including geological advice to oil companies), fossil determinations, regional mapping, compilation of data on potentially economic areas, and assistance to countries of the south-west Pacific on petroleum exploration; advice on siting of geothermal wells and reporting on subsurface geology and fluid-rock reactions; assistance to other countries on geothermal exploration, particularly Indonesia, Philippines, Ethiopia.

Petrology: regional studies of major New Zealand rock types; studies of minerals, ore genesis, ore microscopy, volcanology; instrumental techniques using X-ray, infrared, differential thermal analysis, and electron-probe equipment to determine the presence of specific elements and minerals; study of hydrothermally altered rocks and associated minerals in connection with geothermal investigations; examination of clays from engineering sites; study of volcanic lavas and ashes from Ruapehu, Ngauruhoe, and White Island to help understand eruptive mechanisms; study of minerals in coal and coal reflectance.

Earth deformation studies: co-operation in an interdepartmental and university programme of earth deformation studies; tectonic mapping at a scale of 1:50 000, showing fault traces and deformed surfaces; monitoring of horizontal and vertical movements in tectonically "active" areas; application to siting of major constructions and to town planning.

Engineering geology: studies of the geology, stability, and raw material requirements for dams, tunnels, highways, bridges, ports, and other building sites; emphasis on hydro-electric developments; earthquake microzoning studies showing the relationship between the geology of parts of cities and the response of buildings to earthquakes; slope stability problems; studies of the different properties of rocks.

Environmental geology: geological studies for, and comments on environmental impact reports on engineering, mining, and industrial projects; town and country planning and land inventory.

Special projects: geological mapping in Antarctica (e.g. Cambrian rocks and paleontology of North Victoria Land, as part of an International Geological Correlation Programme); a tectonic map depicting the structural development of New Zealand and the surrounding oceanic shelf during the last 25 million years.

GEOPHYSICS DIVISION

Geophysics Office, Observatory Reserve, Salamanca Road, Kelburn
POSTAL ADDRESS: P.O. Box 1320, Government Buildings, Wellington
TELEGRAMS: GEOPHYSICS Wellington TELEPHONE: 738 208 Wellington

DIRECTOR: T. Hatherton, OBE, DSc *Lond*, PhD *Lond*, DIC, FRSNZ

SECTIONS AND OBSERVATORIES

DRILLING SECTION: Geophysics Laboratory, Gracefield Road, Lower Hutt.
Officer in Charge: J. E. Hoffman (seconded to Apia Observatory for one year).

GEOPHYSICAL SURVEY: Geophysics Office, Observatory Reserve, Kelburn.
Superintendent: W. I. Reilly, BA, DSc, AOSM.

Geophysics Laboratory: Gracefield Road, Lower Hutt.
Officer in Charge: R. G. Jenkins.

Geothermal Laboratory: c/- Ministry of Works, Taupo.
Officer in Charge: G. E. K. Thompson, MSc.

SEISMOLOGICAL OBSERVATORY: Geophysics Office, Observatory Reserve, Kelburn.
Superintendent: R. D. Adams, MA, MSc, PhD *Cantab*.

APIA OBSERVATORY: Apia, Western Samoa.
Acting Superintendent: J. E. Hoffman.

RAROTONGA OBSERVATORY: Rarotonga, Cook Islands.
Officer in Charge: A. F. Cresswell, NZCS.

STAFF: 32 scientists, 32 technicians, and 8 supporting staff.

The work of Geophysics Division extends over a large part of the south-west Pacific extending from Samoa to Antarctica.

The Division consists of five units. Geophysical Survey investigates the types and structures of sub-surface rocks on land and beneath the sea. Such knowledge is required for mineral and geothermal exploration, at engineering sites, and for improving basic understanding of conditions and processes deeper in the earth. A volcanological observatory is also operated on the slopes of Mt Ruapehu. The Drilling Section provides direct information about rocks, temperatures or water conditions at depth, for the Division's own use and for other divisions of DSIR; it is heavily engaged on water supply projects in the Pacific Islands at present.

Seismological Observatory studies earthquakes and their distribution and effects in New Zealand, so that risk to life and property can be assessed. With the Division's observatories in Western Samoa and Cook Islands it contributes readings to international organisations for global analysis. The Division also operates the New Zealand Time Service and disseminates it by wire and radio links.

Current Projects

Geophysical survey: geothermal exploration; groundwater exploration on Canterbury Plains; regional gravity and magnetic surveys; marine geophysical surveys; engineering geophysical studies at Pauahatanui and on Clutha and Hurunui rivers; deep electrical soundings in the central volcanic region; development of well-logging equipment for coalfield investigations; determination of relative movements of ground within New Zealand; volcanological studies.

Volcanology.—Mt Ruapehu is a mildly active volcano. The life and property at risk from eruption has increased greatly over the past few years with the great popularity of the ski fields and the development of the Tongariro power scheme. Geophysics Division has maintained an observatory on Ruapehu for 20 years; with the aid of a Golden Kiwi grant the number of instruments available for studying the mountain increased considerably in 1976. The greatest danger on Ruapehu is from lahars (rock–water mixtures of high density) which originate when the water from Crater Lake is thrown out. The temperature of Crater Lake has been measured for many years by parties visiting the summit, using a simple hand thermometer. During 1976 a prototype buoy with a temperature sensor placed in Crater Lake radio-telemetered the temperature continuously back to the volcanological observatory and operated for almost 3 months before failing. A series of such buoys is being built so that the lake temperature can be continuously monitored.

Seismological Observatory: location of all significant earthquakes in New Zealand region; detailed studies of smaller earthquakes in vicinity of Pukaki and Wellington; search for possible earthquake precursors; estimation of seismic risk for engineers and planners; studies of the earthquake mechanism and source; radon content of groundwater at Kelburn.

Radon content of groundwater at Kelburn.—A number of changes in groundwater conditions known to occur before earthquakes are being examined. Among other effects the rate of flow of water in the ground is changed, and a sensitive measure of flow rate is the emission count of a short-lived isotope like radon. Geophysics Division in conjunction with the Institute of Nuclear Sciences tests samples of water obtained regularly from a borehole in Kelburn to see if such a method may be of use in seismic prediction and to examine how variations produced by other conditions, such as rainfall, can affect the results.

GRASSLANDS DIVISION

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: GRASSLANDS Palmerston North
TELEPHONE: 68 019 Palmerston North

DIRECTOR: R. W. Brougham, BSc, DSc
Agronomy: J. A. Lancashire, BSc, MAgrSc.
Pasture Ecology: W. Harris, BSc (Hons), PhD *Cantuar.*
Plant Breeding: W. Rumball, MSc, PhD *Massey.*
Plant Nutrition: P. R. Ball, MAgrSc.
Genetics: K. K. Pandey, MSc, PhD *Lond.*, DSc *Lond.*, AIARI, FLS.
Turf: G. S. Robinson, MAgrSc.
Liaison: W. G. Thurston, BAgrSc.

REGIONAL STATIONS
KAIKOHE: P.O. Box 194. P. J. Rumball, MAgrSc.
BALLANTRAE (Hill-country): c/- Grasslands Division, Private Bag, Palmerston North. D. A. Grant, MAgrSc.
LINCOLN: c/- Crop Research Division, Private Bag, Christchurch, E. W. Vartha, MAgrSc, PhD *Massey.*
GORE: Private Bag. A. J. Harris, MAgrSc.

STAFF: 49 scientists, and 102 supporting staff.

Grasslands Division undertakes research in many fields of plant and pasture improvement and pastoral agriculture. Through a small network of Regional Stations these activities embrace the warm temperate regions of Northland centred at Kaikohe, South Island high country centred in the Mackenzie Basin, moist and wet North Island hill country centred in the lower Ruahine Range (Ballantrae), intensive Southland sheepfarming centred at Gore, dryland Canterbury regions centred at Lincoln and Kirwee, and alluvial flatlands centred at Palmerston North and the Kairanga Plains (Aorangi). By collaborative research efforts with the Ministry of Agriculture and Fisheries, the Forest Service, the agricultural universities, and progressive farmers, the Division's research effort, especially in plant improvement, also embraces most other climatic and geographic regions of the country.

The Division also has a national responsibility for the production of elite seed (Nucleus and Breeders) of a large number of herbage varieties bred by the Division and for ensuring evaluations of these in many overseas countries. A seed introduction service for herbage plants is also provided for the Ministry of Agriculture and Fisheries, the agricultural faculties of universities, some units of the Forest Service, and for our own use.

Current Projects

Agronomy: species evaluations under mowing and grazing; aspects of pasture utilisation; plant and pasture establishment; seed production; seed certification.

Ecology: temperature, light intensity, and defoliation responses; plant and species competition; pasture "litter" ecology; buried seed studies; plant root studies; plant response to weedicides, pesticides, and fungicides; plant distribution and successional changes; botanical characteristics of herbage plants.

Genetics: molecular and biochemical genetics; cytogenetics; genetics of breeding systems and of rhizobia.

Plant breeding: main breeding efforts are:

grasses: ryegrasses; cocksfoot; timothy; *Bromus; Festuca* and *Lolium* × *Festuca* hybrids; browntop; crested dogstail; *Phalaris;* Yorkshire fog.

legumes: white, red, and alsike clovers; lotuses; *Ornithopus.*

Special topics: plant breeding for better utilisation of phosphate; for tolerance to pasture pests and diseases; for improved nutritive value; for possible bloat resistance; and for improved N-fixation in legumes.

Plant nutrition: electrophysiology characteristics of plant roots; mechanisms of ion uptake; aspects of phosphorus, potassium, nitrogen, sulphur, and minor element plant nutrition; nitrogen fixation and N-cycling in pastoral systems.

Turf research: fertiliser requirements of fine turf; turf management; turf variety evaluations; plant breeding for sports turf.

Regional stations: At all regional stations, research effort covers species evaluations, and for the more promising experimental varieties, as well as for certified varieties, investigations are designed to fit these varieties into agricultural practices in the region. These include: botanical surveys; species and pasture establishment; species growth rates; pasture management and species performance; species evaluations; plant breeding; seed production; weed control; nitrogen fixation and mycorrhiza; plant nutrition and nutrient cycling; protein extraction and chemical composition of pasture; nutritive value of species and pasture; animal disorders related to pasture varieties.

HOP RESEARCH STATION

Main Road, Riwaka
POSTAL ADDRESS: P.O. Box 36, Riwaka TELEPHONE: 515D Motueka

DIRECTOR: A. A. Frost, BSc(Hort).

STAFF: 1 scientist and 4 supporting staff.

This Station is devoted to the breeding and culture of hops and receives some financial support from both brewers and hop growers. Its objects are to ensure that suitable high-quality varieties are available to meet the needs of this country, and to carry out a research role into developing an export trade in this commodity.

The Station has a continuing programme of breeding disease-resistant seedless varieties of exceptionally high bittering power. The most recent commercial release, Roborgh Superalpha, is being distributed to all growers for the first time this season. Its acceptance has been immediate, and the Station is providing the facilities and expertise in propagating about 45 000 plants by the polyethylene tunnel technique described in the 1976 Report.

The objective of many trials is to reduce the cost of production, but to maintain or increase yield and quality. Growing under a total herbicide regime and permanent grassing down are methods, now in their third year of investigation, of dispensing with mechanical cultivations. Each has been adopted already by commercial growers.

The continuous removal of superfluous shoots at the base of the hop is a major source of labour expenditure. A chemical applied as a spray to do this job ceased to be available in 1975, but alternatives have been shown to have great promise—a fatty alcohol and alpha naphthalene acetic acid. Either chemical is used in conjunction with sodium nitrate solution, which gives an immediate desiccating effect.

The industry is now actively searching for overseas markets for hops, in view of serious over-production which has largely been brought about by the introduction of Riwaka-bred high-yielding varieties. The Station's contribution to this search is to investigate the kind of hops and the form of processing and packaging required by the world markets, and to advise the Hop Marketing Board of its findings.

INSTITUTE OF NUCLEAR SCIENCES

Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: PHYSICAL Lower Hutt TELEPHONE: 666 919 Wellington

DIRECTOR: T. A. Rafter, OBE, DSc, FNZIC, FRSNZ.
Accelerator Physics: G. J. McCallum, MSc, FInstP.
Mass Spectrometry: J. R. Hulston, MSc, PhD *McMaster,* FInstP.
Theoretical Physics: B. J. O'Brien, MSc, PhD *Mass.*
Nuclear Instrumentation: J. D. McCormick, FIEE, CE.
Radiation Chemistry: H. C. Sutton, MSc, PhD *Durham* FRSE.
Isotope Chemistry: W. J. McCabe, BSc.
Low Background Studies: H. S. Jansen, MSc.

STAFF: 34 scientists, 19 science technicians, 10 supporting staff.

The Institute was founded in 1959 as a centre for the application of nuclear techniques to problems of national importance in New Zealand. Although nuclear techniques are based primarily on physical sciences, they have widespread applications in such fields as agriculture, natural resources, human health, industrial development, and studies of the environment. A critical assessment of environmental and other problems associated with radiation from fallout and from other nuclear sources is an important part of the work. The successful use of nuclear techniques depends on the availability of sophisticated modern equipment and versatile staff, well trained in recent development in their subjects. A continuing programme of basic nuclear research plays an important part in such training and in the work of the Institute.

Current Projects

Nuclear physics: studies of the nuclear properties of medium-weight elements by bombardment with 3 MeV protons; theoretical studies of nuclear structure using computer-aided calculation; limited production of unusual radioactive isotopes (e.g., of carbon, nitrogen, fluorine, and chromium), and their use in agricultural and medical topics; development of activation and X-ray methods for sensitive chemical analyses; assistance with forensic investigations.

Radioactive dating: fossils, soils, and ash-shower components aged up to 40 000 years (using carbon-14); geological specimens over 100 000 years (potassium-argon dating); lake sediments less than 100 years (using lead-210); studies of exchange processes including carbon movement from the atmosphere to humus and other soil components, the replacement rate of human body tissues, movement of natural waters, and exchange rates of gases between the atmosphere and the surface and deep ocean.

Geothermal studies: an important project is a study of the prospects of the geothermal areas for energy production, especially the new Broadlands field. By measuring radiocarbon and tritium in the borehole, the Institute will try to estimate the rates of draw-off that the fields will sustain indefinitely.

Radiation chemistry: chemical and biological effects of ionising radiation, especially the chemistry of peroxy radicals; biochemical reactions of the superoxide radical ion; development of standards for use in fluorescence and phosphorescence measurements; studies of energy transfer mechanisms in irradiated plastics in order to improve their stability to radiation; application of ionising radiations in development of forest products, in agriculture, and in research on human health.

Radiochemistry: river gauging and effluent dispersion studies by tracer dilution techniques; underground water flow measurement related to water quality; industrial plant kinetics—steam separator efficiency, movement of chips in a pulping plant and mixing efficiency of a concrete batching plant; sediment dating using lead-210 and 'fallout' tracers; actinides in the environment; carbon dioxide levels in the atmosphere; densities of refractory bricks.

Significant Investigations

Nuclear physics: the major experimental facility for this work is a 3 MeV Van de Graaff accelerator. Current interest is focused on the use of X-ray and proton-induced X-ray fluorescence. These new techniques have widespread applications, particularly for analyses of surfaces or thin layers. Typical examples of micron- or tracer-element analyses employing proton-induced X-ray fluorescence are air pollution studies involving analyses for bromine and lead; showing that bromine is absent in soils fumigated with methyl bromide; and the detection of silicon and chlorine in ion-exchange resins, of magnesium in the toenails of radiotherapy patients, and of titanium, manganese, and iron in nematodes; testing of suspected bullet holes for residual copper or lead; analysis of artefacts made from obsidian (volcanic glass) to determine original locality of the material.

Radioactive dating: this technique uses the known decay rates of radioactive isotopes of certain elements to determine the time during which such elements have remained fixed in a given sample. One type of dating, potassium-argon dating, measures ages greater than 100 000 years. It is now an established technique at the Institute, and the second geological age list has been completed. An example of its application is a joint study by Geological Survey, Geophysics Division, and INS, of rocks collected from the Chatham Islands.

Mass spectrometry: The relative abundance of the stable isotopes of selected elements is studied accurately with specially constructed mass spectrometers. Small variations of these relative abundances occur in natural specimens of different origin. Interpretation of these variations in terms of age, temperature of formation, and chemical and biological environment is applied to geothermal studies such as the temperature of geothermal gases at the time of their formation, and to hydrological studies such as the origin of different waters and the mechanism of aquifer recharge.

Atmospheric gases: most of the world's energy needs have so far been met by the large-scale combustion of fossil fuels. This has led to injection of enormous quantities of carbon dioxide gas into the atmosphere with a probable, but as yet, unknown effect on the earth's radiation balance and climate. Automatic equipment for measuring the long-term increase of atmospheric CO_2 has been set up at Baring Head lighthouse by the Institute. Since measurements began in 1972, the atmospheric CO_2 concentration has risen at the rate of 0.4% per year.

NEW ZEALAND OCEANOGRAPHIC INSTITUTE

177 Thorndon Quay, Wellington
POSTAL ADDRESS: P.O. Box 12 346 Wellington
TELEGRAMS: RESEARCH Wellington TELEPHONE: 858 939 Wellington

DIRECTOR: D. E. Hurley, MSc, PhD *NZ*

GROUPS:
Benthic ecology
Sedimentology
Regional and local structural marine geology
Physical and chemical oceanography
Coastal and sheltered water environment
Lake surveys

STAFF: 25 scientists. 13 science technicians, and 8 supporting staff.

The New Zealand Oceanographic Institute was established to investigate the seas around New Zealand. This very broad charter has been developed along three main lines — *physical oceanography,* the study of water masses, currents and their properties, tides and tsunamis; *marine biology,* the study of the living organisms of the sea; and *marine geology,* the study of the ocean floor and the processes involved in its development. In addition, the Institute has adapted marine techniques for research in New Zealand lakes, resulting, in particular, in the production of an extensive series of lake bathymetric charts.

It is the Institute's task to develop a knowledge of the sea, its life and processes, and to be able to provide the best possible advice to those involved in applied fields such as coastal and offshore engineering, disposal of thermal and sewage effluents, offshore mineral recovery and oil prospecting, fisheries research, preservation of the coastal environment, provision of coastal amenities, or even the information on which to base international boundaries. Nevertheless, its approach is essentially research-oriented; practical application comes from increasing knowledge of the fundamental processes involved in the dynamics and life of the seas around us.

The Institute's functions include: basic research on the marine environment; compilation of bathymetric, geological and sediment charts; research on the effects of effluents and pollutants on marine ecological systems, especially in the near shore; the supply of data and advice for applied projects, e.g. harbour works, coastal protection; exploration of marine mineral resources; studies of the dynamic processes of the oceans including upwelling, ocean currents, tides and tidal effects; lake surveys.

Current Projects

Marine biology: benthic ecology of Manukau Harbour, Pauatahanui Inlet and Tasman and Golden Bays; ecology of marine organisms; systematic studies of marine organisms; evaluation of primary productivity and nutrient status of New Zealand waters; the importance of coastal zooplankton in the food chain; studies of effects of fouling organisms on power station systems; biological effects of thermal effluents.

Physical oceanography: studies of circulation and seawater properties off the west coast of North and South Islands; circulation of the Kermadec and Bounty Island regions; detailed studies of the Mid-Tasman convergence; hydrological regimes in coastal inlets; tidal recording; detailed studies of coastal tidal regimes; microstructure of seawater; development of instrument packages for accurate measurement of properties of deep water.

Marine geology: seafloor geology off the west coasts of North and South Islands; surface and sub-surface sediments and structures off south Taranaki and mid-Canterbury; transport of inorganic and biogenic shelf seston (suspended sediment); development of an instrument package to measure seabed boundary conditions of current velocity, pressure fluctuation, variability of sea surface, and sediment movement; sediment transport in Wellington Harbour; Quaternary stratigraphy of shelf and deepsea areas using coccolith and diatom studies; structure and tectonic history of the New Zealand region; geology of the New Caledonia and South Fiji Basins.

Mineral exploration: manganese nodule distribution in the Southwest Pacific; phosphate and glauconite distribution on the Chatham Rise; offshore ironsand distribution, west coasts of North and South Islands.

Chart production: production of coastal, oceanic, and lake bathymetric charts; charts of sediment and marine mineral distribution; biological and physical properties of the sea around New Zealand.

Pauatahanui Environmental Project: multi-disciplinary studies of Pauatahanui Inlet include work on bathymetry, morphology, sediment distribution and transport, littoral and shallow-water ecology, water circulation and properties.

Bibliographies: To assist with background information on areas presently being investigated, bibliographies are being prepared. Recently published or completed bibliographies cover Pauatahanui Inlet; Wellington Harbour; Tasman and Coral Seas; geology of Cook Islands, Niue, Tonga and Samoa; marine oil spills; estuaries; manganese nodules; mangroves in New Zealand; New Zealand marine geology; heated effluents; Marlborough Sounds. Others in preparation deal with Kaipara Harbour Castlepoint area, Lakes Te Anau and Manapouri, Foveaux Strait, and offshore islands.

PHYSICS AND ENGINEERING LABORATORY

Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt TELEPHONE: 666 919 Wellington
TELEGRAMS: PHYSICAL Lower Hutt TELEX: PHYSICS NZ3814

DIRECTOR: M. A. Collins, MSc, FInstP, CEng, MIEE.
DEPUTY DIRECTOR: A. H. Allan, BE ElecCivil(Hons)

Chief Engineer: R. A. Morris, BSc.
Applied Physics: A. H. McIlraith, PhD *Cant,* FInstP.
Biophysics: J. H. Troughton, MAgrSc, PhD *ANU*
Physics: W. H. Robinson, ME *Auck,* PhD *Ill.*
Mechanical Engineering: D. G. McCulloch, BSc, CEng.
Electrical Engineering: R. A. Morris, BSc.
Environmental Physics: G. McK. Allcock, MSc, FInstP.
South Island Divisions: R. S. Unwin, BSc, FInstP.

SUBSTATIONS
CHRISTCHURCH: Geophysical Observatory, St. Elmo Courts, P.O. Box 2111. Telephone 791 540. R. S. Unwin, BSc, FInstP.
LAUDER, CENTRAL OTAGO: Auroral Station, Omakau. Telephone: 467. Telex: AURORA NZ5637. J. G. Keys.

STAFF: 93 scientists, 111 science technicians, and 50 supporting staff.

The Laboratory's functions include: basic and applied research in physics and engineering; maintenance of national standards of physical quantities such as length, mass, temperature; provision of a calibration service for physical measuring equipment; introduction and development of new technology suited to New Zealand's requirements and promotion of its effective use in industry; maintenance of a workshop giving industry access to specialised machine tools and new machine techniques; operation of geophysical observatories at various stations for ionosphere and magnetic observations.

Current Projects

Earthquake engineering: dynamic testing of large buildings; maintenance of accelerometer work throughout New Zealand to measure ground and building behaviour; consultation on bridge design; development of energy absorbers to reduce structural damage to buildings and bridges; dynamic microzoning studies.

Geophysical metrology: recording and analysis of earth strain at tunnel sites; measurement of earth tilt.

Mechanical and production engineering: development of small-scale automation; mechanical testing of components and materials for industry; mechanical engineering design; strain gauge measurements for industry; calibration of anemometers; numerical control advisory service for industry; digital control applications; development of techniques for high-speed photography; tribology advisory service covering friction, wear, bearing materials, specialised lubricants and investigations; electromagnetic forming of metals; machine tool manufacture survey; metal finishing information service; thermal treatment of metals research and information service; advisory service on the selection of computers for business use; general computer information service.

Engineering metrology: maintenance of New Zealand standards of length, mass, pressure, and force; calibration of mechanical measuring equipment for industry; development of measurement methods and engineering metrology; inspection and certification of components, tooling and gauges.

Acoustics: research on impulse noise; reverberant-energy measurements; advice and measurement on industrial, traffic, and aircraft noise; measurement and research on air-blast circuit-breaker noise levels; development of new techniques in acoustic measurement; development of sound-absorption test methods.

Electronic design: automatic weighing, grading, and marshalling of carcasses for the meat industry; computer control of spray-drying milk powder; development of automated experimental data collection for various PEL groups; investigation of the design of high-voltage insulators; advisory service, testing, and measurement for industry; development of industrial test facilities.

Electrical standards: establishment and maintenance of New Zealand standards of electrical quantities and frequency; development of calibration facilities; calibration of electrical equipment; research on VLF transmission of standard frequency signals; advice on location of transmitters and translators in alternative sites to National Parks.

Workshop services: advice to industry on machining methods; provision of special machining facilities; construction of special tools and gauges for industry; provision of workshop services for DSIR; development of scientific instruments for research and development in Government departments.

Remote sensing: development of techniques for using remote sensing for resource surveys; developing techniques for interpreting remote sensing data from earth satellites and aircraft; image processing.

Optics: research and development in geometric optics; development of special optical systems for research and industrial applications; development of computer techniques for lens design.

Photometry: maintenance of New Zealand standards of photometric quantities; testing and calibration of photometric equipment and systems; measurement of beam intensities of lighthouses; research on road lighting systems; effect of lighting on road safety.

Materials science: research on mechanical damping in alkili halides; development of extrusion-energy absorbers for earthquake-engineering applications; behaviour of ionic crystals at pre-melting temperatures.

Molecular physics: research on ultrasonically modulated electron resonance (UMER); electron-spin-resonance studies of unstable radicals by "spin trapping"; action spectra of radiation damage in wool; stress dependence of second harmonic generation from a CO_2 laser.

Biophysics: research on the mechanical properties of wood in relation to its microstructure and moisture content; measurement of the elastic properties of hemicellulose and lignin; research on the structure of New Zealand woods; energy farming; study of translocation in plants using the isotope C-11; research on gas exchange in biological systems; research on the properties of stable foams in relation to bloat in animals and to pollution research.

Electron microscopy: research on membrane structure in biological systems; research on insect sensors; provision of advice and assistance in electron microscopy for a wide range of institutions and organisations; research on morphology of insects' cuticular structure; research on insulation failure; investigations for special industrial studies.

Applied mechanics: development of a computer model of the Hutt Valley aquifer in relation to aquifer management and avoidance of salt water intrusion; geothermal reservoir studies.

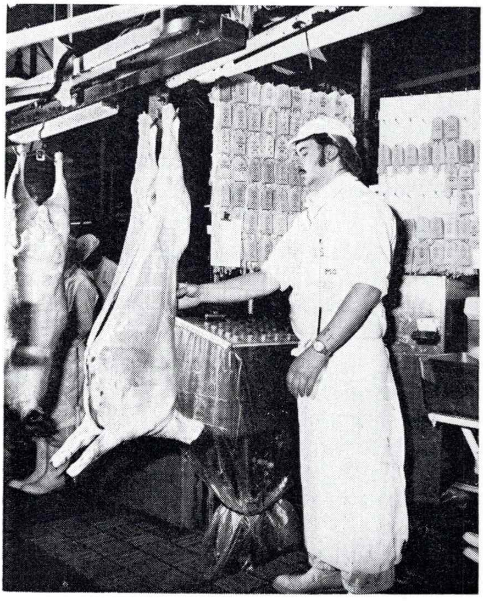
Heat transfer: development of solar water heaters; advice to industry on heat-exchanger design; thermal testing, calibration work, and information service for industry.

Temperature standards: maintenance of New Zealand standards of temperature; calibration and testing work: development of methods for accurate reproduction of temperature and instrument calibration; development of computer control of calibration work.

Upper atmosphere physics: engineering studies of high-frequency mobile communication systems; research on TV forward scatter; development of an acoustic radar for air pollution research; study of radio transmission in the whistler mode; maintenance of an ionosonde network in the Pacific, New Zealand, Campbell Island, and Scott Base; operation of a telemetry station for acquiring data from Alouette/ISIS satellites; auroral-radar research; study of relationships between ionospheric and meteorological phenomena; study of ELF transmissions.

Magnetic survey: maintenance of the National Observatory at Amberley; study of magnetic variations and their causes; magnetotelluric sounding; magnetic effects of high altitude explosions; calibration of aircraft compasses.

Computing: operation, maintenance, and development of software systems for the DSIR national computer network.



Physics and Engineering Laboratory has designed a computerised carcass grading system, here seen in operation at an Invercargill meatworks.

PLANT DISEASES DIVISION

120 Mount Albert Road, Auckland 3
POSTAL ADDRESS: Mt Albert Research Centre, Private Bag, Auckland
TELEGRAMS: PLANTLAB Auckland TELEPHONE: 861 059 Auckland

DIRECTOR: E. G. Bollard, PhD *Cantab.*, FRSNZ, FNZIC.
Bacteriology and Virology: D. W. Dye, PhD *Edin.*
Mycology and Plant Protection: P. J. Brook, PhD.
Nematology (jointly with Entomology Division): F. H. Wood, PhD.
Pomology and Processing: G. Strachan, BS *Oregon S.*
Basic Science: R. L. Bieleski, PhD *Sydney*, FRSNZ.
Scientific Liaison: G. C. Weston, MA *Oxon.*

RESEARCH ORCHARDS
Oratia (Auckland — work being transferred progressively to a new orchard site at Kumeu, Auckland); Te Puke (Bay of Plenty); Havelock North (Hawke's Bay); Appleby (Nelson); Earnscleugh (Central Otago); Totokoitu, Rarotonga (Cook Islands).

VEGETABLE RESEARCH AREA
Pukekohe (South Auckland).

SUBSTATIONS
PALMERSTON NORTH: c/- Grasslands Division. G. C. M. Latch, PhD *Wisc.*
LINCOLN: c/- Crop Research Division. F. R. Sanderson, PhD *Mch.*

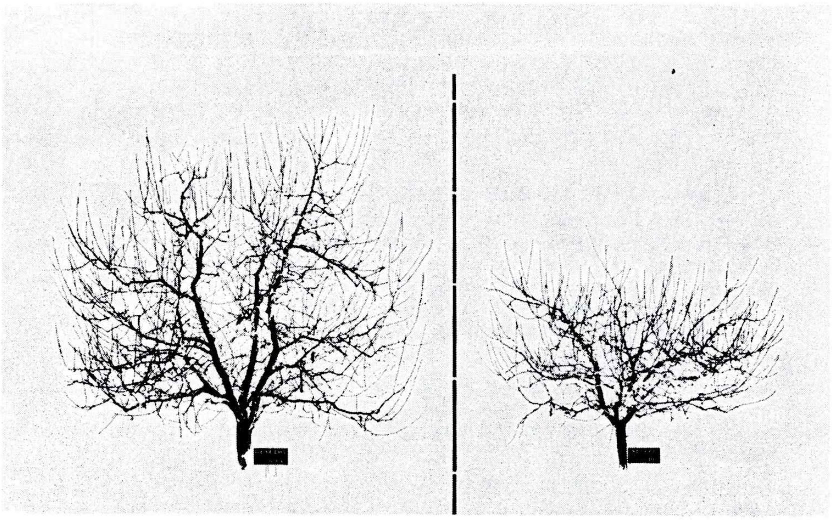
STAFF: 54 scientists, 66 science technicians, and 36 supporting staff.

The Division carries out research on the nature and control of fungous, bacterial, virus, nematode, and physiological diseases of all economic crops; the taxonomy of fungi and bacteria; plant physiology, especially on mineral nutrition and growth substances; the production, storage, and processing of vegetables and of pip, stone, citrus, and subtropical fruits; and disease and horticultural problems in the South Pacific region.

Current Projects

Bacteriology and virology: control of bacterial diseases in orchard trees, field crops, vegetables, and horticultural plants; taxonomy of plant bacteria; use of bacteria in agriculture, nitrogen fixation by *Rhizobium* and *Azotobacter*, use of bacteria antagonistic to pathogens; national reference culture collection of plant bacteria and fungi; identification and control of viruses of economically important plants; studies of virus transmission methods and identification of insect vectors; production and maintenance of virus-free clones of deciduous fruits and grapevines.

Mycology and plant protection: studies of fungi causing damping off and root rots of horticultural and field crops, pasture plants, and trees; fungi causing airborne diseases of pasture plants, maize, berry fruits, grapevines, tree fruits, and a variety of vegetable and arable farm crops; diseases of turf; chemical and other means of controlling fungus diseases; seed pathology; climate in relation to epidemics; pasture fungi in relation to animal disorders; taxonomy of New Zealand fungi, and maintenance of a herbarium; relations of imperfect to perfect stages of fungi; records of plant pathogens in New Zealand.
Nematology: joint programme with Entomology Division (q.v.).



These silhouettes, of typical apple trees selected from a 'Jonathan' apple mosaic virus yield trial in Nelson, show the effect on tree growth of a severe strain of mosaic (right) compared with a mosaic-free tree (left): the scale is in metres.

Pomology and processing: evaluation of varieties, rootstocks and cultural practices for temperate and subtropical fruits; testing of possible new fruit crops; crop forecasting; prevention of frost injury; chemical regulation of plant growth; post-harvest physiology, and control of storage disorders; controlled-atmosphere storage; chemical composition of fruits and vegetables; preservation of fruits and vegetables by canning, freezing, dehydration ,and chemical methods; development and improvement of food and juice products.

Basic science: regulation of plant metabolism; mineral nutrition of plants, particularly nitrogen, phosphorus, and calcium; assessment of nutrient status of plants; transport of solutes in higher plants and in fungi, including mycorrhizas; physiology of fungi and mycorrhizas; mycorrhizas in nutrition and disease of horticultural, ornamental and orchard crops; chemistry and physiology of bacterial and fungal toxins; identification, estimation and synthesis of biologically active compounds; application of mass spectrometry to the study of biologically active compounds; sterile culture of plant tissues; scanning and transmission electron microscopy of higher plants, fungi, bacteria, insects, and their cells; development of methods for electron microscope studies.

Activities in the South Pacific: assistance with the UN Development Programme/FAO Survey of Agricultural Pests and Diseases in the South Pacific region; development and curation of reference collections of fungal herbarium material and cultures of bacteria and fungi from South Pacific crop plants; taxonomy; disease records. Maintenance and development of the Totokoitu Research Station, on Rarotonga; problems of citrus and banana production, of subsistence crops, and other fruit crops.

PLANT PHYSIOLOGY DIVISION

Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: PLANTPHYS Palmerston North
TELEPHONE: 68 019 Palmerston North

DIRECTOR: J. P. Kerr, MAgrSc(Hons), PhD.

CLIMATE LABORATORY
Climate Room service: I. J. Warrington, MHortSc(Hons).
Instruments systems: R. W. Robotham.
Forage and Crop Development: A. O. Taylor, BSc(Hons), PhD.
Plant Biochemistry: C. R. Slack, BSc, PhD.
Crop Physiology: H. G. McPherson, MAgrSc(Hons), PhD.
Tissue Culture and Genetic Engineering: W. D. Sutton, BSc(Hons), PhD.
Agricultural Physics: K. G. McNaughton, BSc(Hons), PhD.

STAFF: 30 scientists, 18 science technicians, and 7 supporting staff.

Plant Physiology Division is concerned with the physiology of adaptation of plants to the New Zealand climate. Research is undertaken on aspects of photosynthesis, lipid biosynthesis, temperature and water stress physiology, genetic engineering, and evapotranspiration. Current interests include the development of conserved forage crops for animal production systems and the application of tissue culture techniques.

Core disciplines are crop and whole plant physiology, biochemistry, agricultural physics, genetic engineering, and agronomy.

Climate Laboratory

The Division is responsible for running the Laboratory as a national research facility available to scientists in all New Zealand research institutions. The laboratory consists of 24 controlled-environment rooms in which temperature, humidity, daylength, light intensity, and carbon dioxide levels are controlled. Trained staff are available to supervise experiments and maintain the Laboratory.

Current projects include: South Island beech and *Pinus radiata* seedling growth and development under simulated clear- and select-felling operations; yield responses of maize and forage lupin to moisture stress; effects of nitrogen fertiliser on baking quality in New Zealand wheats; flowering and vegetative responses of lotus, lucerne, and introduced legumes to temperature, daylength, and simulated grazing regimes; vegetative growth responses of pasture grasses to temperature and drought; influence of various temperature treatments on bud development and vegetative growth in Chinese gooseberry and *Pinus radiata;* seasonal response of various *Pinus* spp. to frosting treatments; thermotherapy to eliminate viruses in various nursery species.

Current Projects

Forage and crop development: evaluation of conserved feed systems based on forage crops; field and laboratory evaluation of cool season legumes, including studies of nitrogen fixation; field evaluation of summer grass introductions in Northland in pure and mixed swards;

cool tolerance in maize genotypes; rust-resistant loci and related yield factors in oats; basic studies in photorespiration.

Plant biochemistry: biosynthesis of polyunsaturated fatty acids in plants; investigation into the feasibility of predicting *in vivo* digestibilities of forage samples using an incubation with fungal cellulases; studies of seed development, oil composition, and biosynthesis in safflower hybrids.

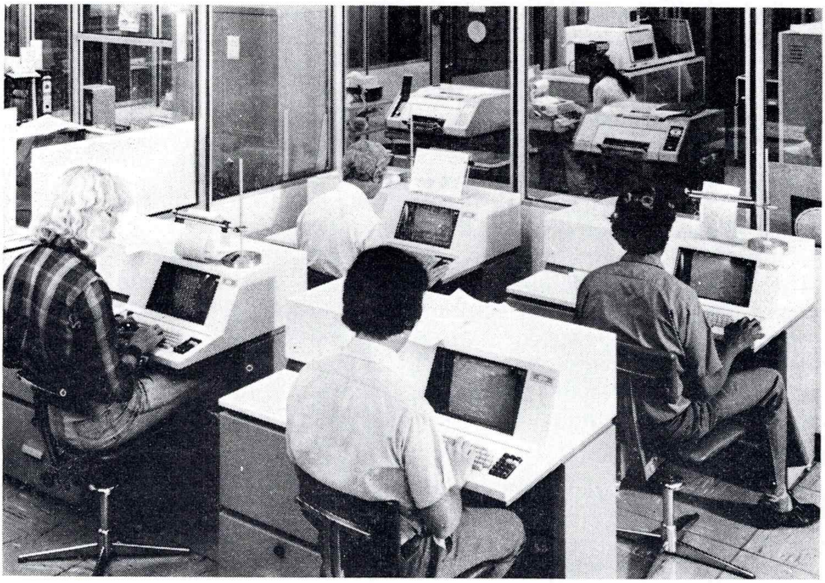
Tissue culture and genetic engineering: clonal propagation of virus-free ornamental plants after thermotherapy; rapid micropropagation of poplar species and other soil conservation trees; introduction of nitrogen-fixing genes into fungi; metabolism of detached lupin root nodules in culture.

Agricultural physics: microclimate modification using a mobile wind barrier; studies of the growth and nitrogen balance of a maize–winter oats rotation; transient temperature techniques for measurement of heat and mass transfer in leaves; evapotranspiration and water balance studies of winter oats.

Crop physiology: water-use adaptation to drought in maize; leaf growth of pasture species in response to plant desiccation; diurnal and seasonal changes in water potential and stomatal resistance of irrigated and stressed apple trees; gas exchange measurements of photosynthesis and stomatal response.

The Government Printer has installed a computer printing facility (shown in the background) and is hoping to use it increasingly for Government publications. Although type can be set using a video screen as shown here, suitably prepared clean copy can also be fed into an optical character recognition device (behind the glass screen) and converted direct into type. When required, Science Information Division will be producing such copy on the Wang word processor, which enables editorial amendments to be incorporated without spoiling the copy.

Photo: National Publicity Studios



SCIENCE INFORMATION DIVISION

Cubewell House, 16-17 Kent Terrace, Wellington
POSTAL ADDRESS: P.O. Box 9741, Wellington
TELEGRAMS: SIDSIR Wellington TELEPHONE: 858 939 Wellington

SUPERINTENDENT: G. J. Neale

N.Z. Journal of Agricultural Research and
N.Z. Journal of Experimental Agriculture: M. J. Baker BScAgric(Hons).
N.Z. Journal of Botany: Q. W. Ruscoe, PhD *Exon.*
N.Z. Journal of Geology and Geophysics: I. W. Mackenzie, BA, DipNZLS.
N.Z. Journal of Marine and Freshwater Research: E. K. Saul, BSc.
N.Z. Journal of Science: J. G. Gregory, MA *Oxon.*, AIInfSc, MAIE.
N.Z. Journal of Zoology: C. T. Duval, BSc.
Bulletins: D. J. Zwartz, BSc.
Supervising Photographer: J. J. Whalan.
Chief Cartographer: F. J. Tindall.
Chief Librarian: P. Szentirmay, ANZLA.

STAFF: 13 scientists and 54 supporting staff.

Science Information Division provides editorial, cartographic, library, photographic, and information assistance for all DSIR divisions and sections. It handles the printing, distribution, and sales of publications, as well as publicising the work of DSIR.

Current Projects

Cheaper methods of publication; use of the Wang "word processor" and interfacing it with the Government Printer's computer printing; alternatives to normal publication, e.g. microfiche; DSIR Indexing System (SIRIS) for New Zealand science.

Activities

Editorial section: Research by New Zealand scientists or by visiting scientists on topics of direct importance to New Zealand is published in the seven journals listed above.

Specialised bulletins, principally on geology, soils, and oceanography, are produced, and a limited number of books of more general interest are issued. The section also handles industrial advisory leaflets and publicity handbooks.

Central Library: Central Library contains a comprehensive selection of bibliographies, abstracts publications, and indexes, and provides a service for editors and authors. It also handles the purchasing of books and periodicals for the whole Department, keeps a Union Catalogue of DSIR holdings, and co-operates in an extensive interloan system.

Cartographic section: Maps dealing with geology, geophysics, oceanography, lakes, and soils are published by DSIR, and the cartographic section prepares drawings and overlays for printing. All classes of draughting, including the preparation of line drawings and diagrams to illustrate scientific papers, but excluding mechanical design drawing, are provided.

Photographic section: General, technical, and experimental photography is done for Head Office and the Wellington branches. The section provides a cine film unit for the Department and keeps a small collection of scientific and technical cine films.

Information section: Information complementary to the formal scientific publications is disseminated through the daily and technical press and other news and information media.

SOIL BUREAU

Eastern Hutt Road, Taita
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: SOBUR, Taita TELEPHONE: 673 119 Wellington

DIRECTOR: R. B. Miller, BA, MSc, Agr 1 (Sweden), FNZIC, FNZIAS.

Chief Pedologist: M. L. Leamy, DSc *Well.*
Soil Correlation: J. D. Cowie, MSc.
Soil Interpretation: E. Griffiths, BSc.
Chemistry: A. J. Metson, MSc, FNZIC. FNZIAS.
Analysis: L. C. Blakemore.
Soils and Nutrition: W. B. Healy, MSc, PhD *Rutgers,* FNZIC, FNZIAS.
Biochemistry: D. J. Ross, MSc, PhD *Lond.,* DipBact *Lond.,* FNZIC.
Biology: G. W. Yeates, BSc(Hons), PhD *Cantuar.*
Physical Chemistry: N. Wells, BScSp.
Engineering: R. D. Northey, MSc, PhD *Lond.,* DIC.
Physics: R. J. Jackson, BSc(Hons), PhD *Dunelm.*
Scientific Administration: R. J. Furkert, MSc, PhD *Well,* CChem, MRIC.

DISTRICT OFFICES
AUCKLAND: Soil Survey, c/- Plant Diseases Division, Private Bag.
J. E. Cox, MA *Cantab.*
HAMILTON: Soil Survey, Anglesea Bldg, cnr Collingwood and Anglesea Streets. P.O. Box 1193.
G. E. Orbell, MSc.
WELLINGTON: Soil Bureau, Eastern Hutt Road, Taita. Private Bag, Lower Hutt.
J. D. G. Milne, MSc, PhD *Well.*
NELSON: Soil Survey, cnr Milton and Halifax Streets. Private Bag.
I. B. Campbell, MSc.
ROTORUA: Soil Survey, c/- Forest Research Institute, Private Bag.
W. A. Pullar, DSc, AOSM.
HAVELOCK NORTH: Soil Survey, DSIR, Goddards Lane.
E. Griffiths, BSc.
PALMERSTON NORTH: Soil Survey, c/- Grasslands Division, Private Bag.
J. D. Cowie, MSc.
LINCOLN: Soil Survey, c/- Crop Research Division, Private Bag, Christchurch.
T. H. Webb, MAgrSc.
DUNEDIN: Soil Survey, P.O. Bldg, Moray Place. P.O. Box 5133.
D. M. Leslie, MSc.
GORE: Soil Survey, c/- Grasslands Division, Private Bag.
J. G. Bruce, MSc.

STAFF: 65 scientists, 30 science technicians, and 16 supporting staff.

The Bureau studies the soils of New Zealand, some Pacific Islands, and the Antarctic to provide fundamental data for land use and soil engineering. The studies include mapping and classification of soils according to their morphology and genesis; characterisation of each soil and its physical, chemical, and biological properties; gauging of each soil's potential capacity to change under changing conditions; communications of these findings and their implications to others working on related problems; interpretation of findings in national and regional land use planning.

Current Projects
Soil resources: appraisal of soils for regional development, King Country; appraisal of soils for forestry development, Westland and Southland; soil surveys of counties, catchments and basins, urban areas, and other areas of special importance; determination of the soil re-

sources of the Pacific Islands — Cook Islands and Tonga; soil group definition and regional studies; techniques and application of detailed soil surveys; revision of New Zealand genetic soil classification; evaluation of remote sensing and grid sampling techniques in soil surveying; correlation of crop productivity data with soil units; soil structure changes under forestry; classification of land for irrigation, forestry, and food production; soil/forest productivity studies; evaluation of soils for different kinds of urban use; soil resource information — interpretation and application to indicative planning; nature of volcanic ash showers; determination of ages of volcanic surfaces, correlation of ash marker beds; loess as a soil parent material; studies of current loess deposition; detailed soil surveys of arable land; detailed studies of acid sulphate soils; detailed studies of soils susceptible to accelerated erosion under forest use and under urban use.

Life sciences: chemical properties of soil particle size fractions; Pauatahanui environmental investigation; effect of grass species on sulphur availability; population dynamics of pasture nematodes; effects of management on nematode populations in pastures; influence of nematodes on clover growth and nitrogen fixation; nematodes from New Zealand, Chatham Islands, Campbell Island soils; seasonal activity of arthropods in beech forest litter; beech forest studies on litter fauna, microflora, and comminution of organic matter by the detritus-feeding beetle *Holotrochus;* taxonomy of *Holotrochus;* distribution of actinomycetes and other soil bacteria and protozoa in the New Zealand region;

A comprehensive interdepartmental investigation of the Pauatahanui Inlet near Porirua is nearing completion. It will be the first survey to show the characteristics of a recreational area and the probable effects of further development on it before planning decisions are implemented.

Massey effluent trial; ^{14}C measurement of organic matter turnover; use of isotopic methods to study cycling of sulphur; investigation of relationships between soil organic chemistry and environmental parameters in New Zealand soils; humic and non-humic substances, including carbohydrates, polyphenols, and organic phosphorus compounds in New Zealand soils; metabolism of soil organic matter; range of studies on a climosequence of soils in tussock grassland including activities of a number of enzymes of soil and plant fractions, respiratory activity, and nitrogen mineralisation; chemistry and enzymology of litter decomposition; cellulose decomposition; availability of nitrogen for plant growth in yellow-grey earths in tussock grasslands; influence of temperature on biochemical processes in soils; soil sulphatase activity and the supply of organic S for plant growth; availability of soil organic P fractions for microbial growth.

Chemistry and data centre: chemistry and fertility of Cook Islands and Tongan soils; element analysis of soils and plants as an index of soil fertility; use of laboratory data in soil taxonomy; reserves and availability of the major plant-nutrient elements Mg, K, and S in New Zealand soil groups; surface movement of plant nutrients on pasture slopes during rain storms; acid sulphate soils; chemistry of gley podzols; forest tree nutrition and assessment of soil and site suitability for exotic forestry programmes; development of analytical methods for soil and plant constituents; element distribution in deep loess profiles; New Zealand soil data base, computer-based soil classification file; data storage, collation, and correlation.

Physics and physical chemistry: moisture regimes of New Zealand and Cook Islands soils; aggregate stability of New Zealand soils under cropping; physical properties of pumice soils; unsaturated hydraulic conductivities of New Zealand soils; soil physical properties in relation to catchment hydrology; soil engineering problems associated with Mangaweka deviation of North Island Main Trunk Railway; gamma ray attenuation determination of continuous density profile of soil cores; urban development engineering soil surveys; study of runway failures at Wellington Airport; underground corrosion of steel, cement products, ceramic field tiles, rubbers, and plastics; lime stabilisation of New Zealand soils; stem-flow and throughfall of rainwater on vegetation; geobiochemistry of rocks, soils, and plants; mineralogy of Tongan and Cook Island soils; reaction of fluoride ions with soils; element distribution in soil profiles; weathering processes in Antarctic soils; clay–organic matter interactions; waste water irrigation of soil columns; beneficial action of sewage sludge on plants; utilisation of Singapore sewage sludge; geochemistry of iron and manganese in soils; study of iron in soils by Mössbauer spectroscopy; element and mineral distribution in aquatic communities; reactions of model organic compounds with topsoils; nature and origins of hydrous micas in soils.

TOBACCO RESEARCH STATION

POSTAL ADDRESS: R.D. 3, Motueka
TELEGRAMS: TOBACCO RESEARCH Motueka TELEPHONE: Motueka 501

SUPERINTENDENT: R. W. James, BSc *SAN*

The station, which was established in 1938, is responsible for research into all aspects of tobacco production in New Zealand from the seed to the point of manufacture.

Current Projects

Plant Breeding: breeding and selection for resistance to verticillium wilt, black root rot, phytophthora, blue mould, and tobacco mosaic virus; improvement of leaf quality characteristics including physical and chemical attributes; plant introduction and evaluation; regional testing programme of introduced and bred varieties; production of nucleus seed stocks; treatment of all commercial seed.

Agronomy: effects of cultural and management practices on leaf quality, yield, chemical and physical properties; chemical control of sucker growth, rate of ripening, and carbohydrate assimilation; air-cured tobacco types.

Chemistry: investigation of leaf-soil nutrient relationships, basic chemical and physical characteristics of New Zealand leaf.

Activities

The tobacco crop grown in New Zealand is mainly flue-cured and the research effort is therefore concentrated on this variety of *Nicotiana tabacum*. Verticillium wilt is only known to infect tobacco in New Zealand. The station started seeking sources of resistance within the *Nicotiana* genus in 1948 and released the resistant flue-cured tobacco cultivar, Waimea, in 1967 and Kuaka 427, in 1973. A later selection Kuaka 860 with improved characteristics will be released in 1977.

Economic improvements in the management of the crop have resulted from research into planting on ridges, the use of fatty alcohols to control axillary bud growth, plant spacing and maturity of leaf at harvest, herbicides for weed control, and field fumigation with metham sodium for broomrape (*Orobanche minor*) control.

Liaison with all sections of the industry is maintained through the Tobacco Research Committee.

The Tobacco Board supports the activities of the station by contributing 0.65% of the total value of the crop sold each season to the Consolidated Fund.

WHEAT RESEARCH INSTITUTE

197 Hereford Street, Christchurch
POSTAL ADDRESS: P.O. Box 1489, Christchurch
TELEGRAMS: WHEAT RESEARCH INSTITUTE Christchurch
TELEPHONE: 791 548 Christchurch

DIRECTOR: R. W. Cawley, MSc, FNZIC.
Basic Research: P. Meredith, MSc, PhD *Birm.*
Baking Technology: T. A. Mitchell, MSc.

STAFF: 6 scientists, 7 science technicians, and 2 supporting staff.

The Institute does research and other scientific work for the wheat growing, flour milling, and baking industries.

Research is concentrated on a few chosen subjects, but information and advice are available on many aspects of cereal technology; mechanical handling of grain and flour; storage; drying; entomology and mycology; flourmilling; grinding; sieving; particle-size analysis; bread, cake, and biscuit making; pasting and thickening; and nutritional aspects of cereals as human food and animal feed.

Flourmillers make extensive use of the Institute's test milling and baking services to help maintain uniform quality. Flour samples from all mills are regularly tested for the New Zealand Wheat Board.

Current Projects

Basic research—the developing cereal grain: Grains have been harvested every few days, from time of emergence of the flowering ear to ripeness and beyond, in studies of the anatomical and chemical changes of grain development. The programme, now in its seventh season, has included several varieties of European and Australian wheats as well as local varieties of wheat, oats, barley, ryecorn, and triticale.

Many aspects of grain growth are being studied, including simple measurements of weight gain, studies of starch granule development, the enzymes involved in starch synthesis and, in collaboration with workers in Canterbury University, light and electron microscopy studies of grain structure and C-13 nuclear magnetic resonance studies of the sugars of developing grains.

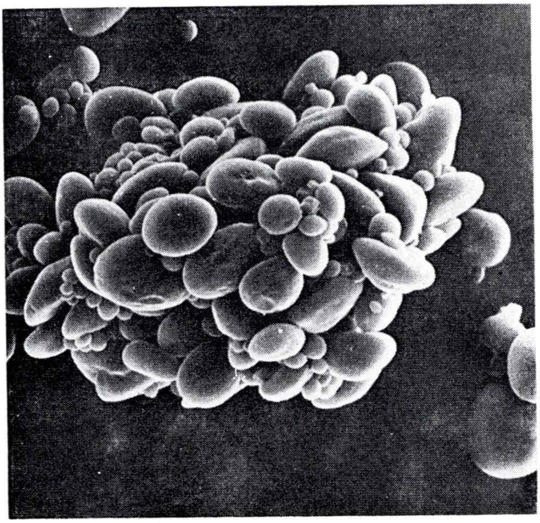
Baking technology—milk in bread: Milk powder improves the nutritional status of bread, but often damages loaf volume and crumb texture, especially in bread made by the mechanical dough development process. A method of incorporating milk powder is under development. If successful, the process could be used to make better bread in New Zealand, to assist milk powder exports, and to allow developing countries to make acceptable bread of high nutritional value.

Activities

Breeders' material is tested for milling and baking quality at the Wheat Research Institute. Finance is derived from a levy on the flourmilling and baking industries and from a Government grant.

Since 1964 the Institute, at the request of the Flour Millers Association, has provided a wheat testing service which now forms an essential part of the system for marketing the local crop. This service

The scanning electron microscope provides greatly magnified three-dimensional images of samples, in this case wheaten cornflour.



supplies flourmillers with information on the baking quality of individual parcels of wheat at time of purchase. During the wheat harvest, grain merchants forward samples to the Institute where they are milled and baked at the rate of one per minute, each sample taking 5 hours to pass through the system. Millers can thus select the best wheat for milling and exclude wheat with serious defects such as sprout and "bug" damage. With modern bulk harvesting, prior knowledge of the quality of each parcel of wheat, provided by the Institute's testing service, is essential before the wheat can be tipped.

The Institute has made an intensive study of the "mechanical dough development" process and its application under New Zealand conditions. It is now used to make about 70% of the bread in New Zealand.

CAWTHRON INSTITUTE

98 Halifax Street, Nelson
POSTAL ADDRESS: P.O. Box 175, Nelson TELEPHONE: 82 319 Nelson

DIRECTOR: R. H. Thornton, MAgrSc, PhD.

Chemical and Biological Services: A. Cooke, BSc, LRIC, MNZIC.
Environmental Services: J. Bamford, BSc(For), BSc, PhD.

STAFF: 12 scientists, 14 science technicians, and 6 supporting staff.

The Cawthron Institute's research programme is directed toward the microbiological degradation of natural and man-made organic materials. Knowledge and understanding of the ways in which microbes degrade and transform organic materials is applicable to study of water and soil quality, nutrient cycling, waste utilisation and treatment, and microbial fermentations.

An Analytical and Consultant Section provides industry, agriculture, local and ad hoc authorities with confidential chemical and biological analyses. In addition environmental assessments and reports are carried out.

Current Research Projects

Water quality: heterotrophic microbial activity and biomass estimations in lakes; nutrient transformations, especially nitrogen, in estuarine sediments and waters; bacterial degradation of algae and nutrient transfer and cycling; transferable antibiotic resistance in coliform bacteria in natural and polluted fresh and marine waters.

Waste utilisation: microbial fermentation of *Pinus radiata* bark constituents; fungal degradation of tannins; energy production from cellulose materials by linked continuous fermentation producing alcohol and methane; biochemistry of methanogenesis; proteolytic and cellulolytic degradative processes; polysaccharides from fermentation of wastes.

Analytical and Consultant Services

Agriculture and horticulture: quality control in meat and dairy processes; soil and plant analyses for pastoral agriculture, tobacco and turf culture; mite counting for orchardists.

Forestry: quality control of export wood chips; pine needle analyses.

Manufacturing: Product testing for Consumer's Institute; hop resin analyses; quality control of products and processes in food, wine and fruit processing industries; miscellaneous product and process development; bacteriological testing; antibiotic and vitamin determinations.

Local and ad hoc authorities: water testing and pollution monitoring; miscellaneous investigations.

Environmental services: feasibility studies; advice on environmental aspects of development projects; environmental impact assessments and reports.

BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND (Inc.)

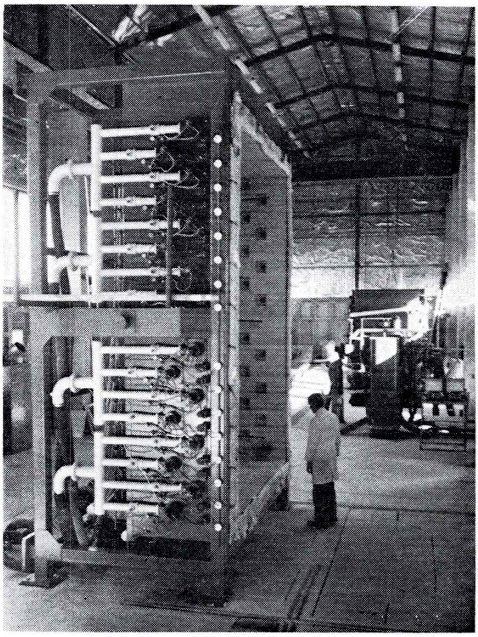
42 Vivian Street, Wellington
POSTAL ADDRESS: P.O. Box 9375, Wellington
TELEGRAMS: BRANZ Wellington TELEPHONE: 851 479 Wellington

DIRECTOR: P. K. Foster, MSc, PhD, DIC, FNZIC.
ASSISTANT DIRECTOR: I. C. Hope, BSc, MIF.
Appraisal: J. Baty, BSc, CEng, MIEE, ANZIM
Components: H. A. Trethowen, BEMech, MNZIE, MIMechE, MIHVE.
Fire: D. Bastings, BE, MNZIE.
Information: L. T. Bowen, ANZIA, ARIBA.
Management: D. G. Miller, BA, MNZ PsychS, ANZIM.
Materials: R. S. Whitney, BSc Tech, PhD, MNZIC.

REGIONAL ADVISORY OFFICES: Auckland, Wellington, Christchurch, Dunedin.

STAFF: 26 scientists, 8 science technicians, 14 supporting staff.

The Association provides information and a technical advisory service for the building industry, and promotes and conducts research for the industry. Test facilities are available in limited fields including fire, heat, and moisture, acoustics, and materials testing. TELARC (Testing Laboratory Registration Council) registration has been secured for some of these tests and registration for other tests will be sought as appropriate. Test facilities are generally used for research projects and, in association with clients, for product development testing.



The fire-resistant wall furnace at Judgeford. It is used for testing specimens of walls made from normal bulding materials, and takes specimens up to 3 m wide and 4 m high. A smaller pilot furnace is seen in the right background.

Publications include research papers, technical papers, bulletins and (in association with New Zealand Master Builders' Federation) the journal *Construction*.

The formal examination of new products and systems, and the issue of appraisal certificates, has continued. Each certificate provides a source of soundly based independent opinion, but leaves the responsibility for approval with the specifier or authority as hitherto. Activity in this field has led the Association into contributing to new designs and developments, and has stimulated research and testing in new directions.

The demand for information has intensified during the past year. Information retrieval has been speeded up with the introduction of key words and the optical coincidence system; in this area there is close co-operation with the Ministry of Works and Development. The advisory service continues to serve the industry by disseminating knowledge and helping with technical problems; the number of formal lectures during the year has again increased.

Current Projects

Durability of building materials; natural weathering of roof paints and vertical weatherboards; natural and accelerated weathering of exterior grade particleboards; loss of strength of particleboard flooring from exposure before laying, and its long-term performance; pitting corrosion of anodised aluminium, sulphur dioxide corrosion of steel, and corrosion of metal fasteners in timber; strength of nail joints, and the durability of elastomeric joint sealants; the performance and durability of alternative materials for freezing-works floors; the provision of natural exposure testing facilities for the building industry.

Field observations of the performance of buildings, components and materials, with special interest in windows, roofing, external cladding, joint design.

Short- and long-term testing of thermoplastic piping for suitability for hot water systems; design and commissioning of equipment to record digitally water usage data; design and testing of hot water storage cylinders and methods of installation to resist earthquake damage.

Design and testing of thermal insulation, including application to panel systems and concrete masonry; further investigation of building moisture and the development of a more reliable method for the design of moisture control measures in timber framed structures; examination of the influence of the mass of a building on its space heating energy requirements; compilation of data for optimising windows for heat energy conservation; control of inter-tenancy noise in multi-unit dwellings, testing of sound absorbers, and compilation of a directory.

The establishment, standardisation, and calibration of the fire test furnaces and their operation and control; tests on materials and constructions; the development of new design configuration; development of programmes of research into various aspects of fire behaviour in relation to building design and construction.

Study of building contract time and cost; investigation of the cost of accidents; recommendations for the safe use of lasers; examination of crane accident statistics, recommendations for safety training programmes; examination of determinants of productivity in Australian housebuilding.

NEW ZEALAND COAL RESEARCH ASSOCIATION (Inc.)

DSIR No. 2 Bldg., Gracefield Road, Lower Hutt
POSTAL ADDRESS: P.O. Box 3041, Wellington
TELEGRAMS: COAL Wellington TELEPHONE: 662 289 Wellington

DIRECTOR: P. A. Toynbee, BSc, DIC, MIChemE, MIF, MNZIE.
EXECUTIVE OFFICER: D. L. Jones.

COAL ADVISORY OFFICES: Auckland, Hamilton, Palmerston North, Christchurch, Dunedin.

STAFF: 7 scientists, 20 science technicians, 3 supporting staff.

The Association's activities are directed to the promotion of existing and new coal markets and to the replacement of imported fuel oil with indigenous coal. These efforts are concentrated on improving the quality of coal delivered to the user, ensuring greater cleanliness, convenience and efficiency in the handling and use of coal, maintaining an analytical service for the coal industry, and providing a national advisory service to coal users.

Current Projects

Coal analysis: analysis of core samples from drilling programmes, of geological and prospecting samples, and of samples of mine production and of industrial coal.

Fundamental studies: basic work directed to a better understanding of the properties of New Zealand coals, which in many ways differ from those found overseas.

Appliance development: design of domestic, commercial, and industrial coal-burning appliances to suit New Zealand coals. This work is determined largely by existing gaps in the availability of coal-fired appliances; by the need for a clean environment; and by the need to use coal to the maximum advantage to the national economy and provide a fuel to meet the impending shortages of fuel oil and electricity.

Materials handling: development and installation of modern industrial coal-handling methods, especially of enclosed transport systems from enclosed bunkers, for automatic and dust-free operation; design of bunkers; introduction of containers for coal transport.

Pulverised fuel: application of pulverised coal to the firing of industrial boilers and to industrial drying processes; design of burners, pulverisers, classifiers, grit arrestors.

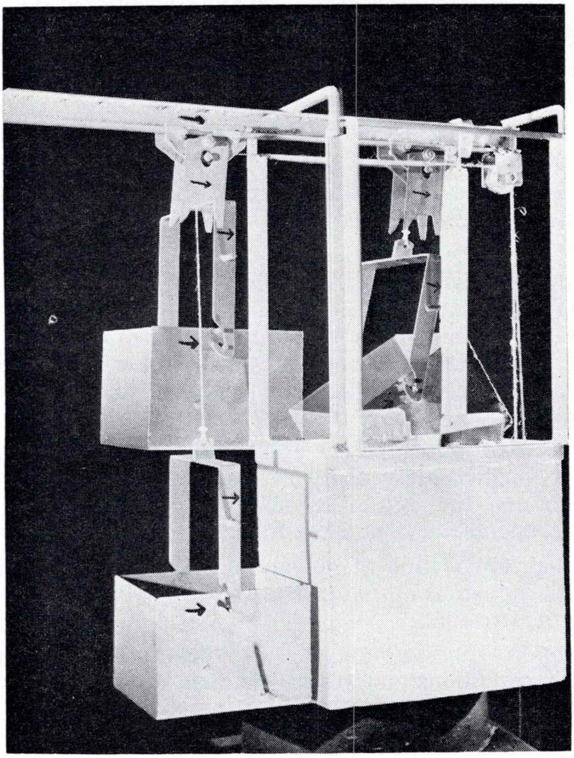
Coal preparation: consideration of coal-preparation plant for use under New Zealand conditions; improved methods of up-grading slack coal; drying of coal.

Activities

The increasing reliance on coal as a source of indigenous energy has brought a greatly-increased activity in the exploration of coal measures. Drilling programmes have been mounted in several areas to determine the extent of the country's coal reserves, and the Association is responsible for the analyses of the core samples from this drilling.

Chemical research projects are directed to a better understanding of New Zealand's unusual sub-bituminous coals. A better appreciation of the extremely high reactivity of these coals has led to the design of more suitable appliances, but this phenomenon is not completely understood, and a laboratory investigation is being carried out to provide further information on this unusual property.

The energy crisis has highlighted the importance of the engineering work that has been carried out by Coal Research Association over the last nine years, and brings the right climate for implementing the findings of this research—the achievements in improving the convenience and cleanliness of all forms of coal firing, the development of coal-fired space heaters acceptable for use in clean air zones, the developments in pulverised-fuel firing, the improvements in storage and handling of coal within factories, are all facets of the progress that has been made and which is now being put into practical use.



This multiple-exposure photograph shows successive steps in discharging coal into a customer's bunker. The Coal Research Association is working to improve the convenience and cleanliness of coal handling.

NEW ZEALAND CONCRETE RESEARCH ASSOCIATION

13 Wall Place, Porirua
POSTAL ADDRESS: P.O. Box 50156, Porirua
TELEGRAMS: CONSEARCH Porirua TELEPHONE: 8379 Tawa

DIRECTOR: J. E. F. Field, BSc, MNZIE.

STAFF: 4 scientists, 5 science technicians, and 1 supporting staff.

The Association's work in the field of concrete materials technology has continued with particular reference to the performance of concrete in terms of strength, durability, and dimensional stability as influenced by the characteristics of its constituents and their proportions. Specific investigations in co-operation with cement user organisations have increased in number, indicating an increasing awareness on the part of the concrete industry of the value to it of research and development facilities.

Training and education activities have continued with courses and seminars being arranged at various times during the year.

Current Projects

Concrete aggregates: the potential of new sources of material in concrete making in relation to the proved qualities of existing materials has been emphasised.

Concrete masonry: development of valid procedures for determining the characteristic strength and permeability of concrete masonry.

Concrete admixtures: evaluation of new concrete admixtures for the production of shrinkage-compensated, water-reduced, and self-flowing concrete.

Strength development: determination of strength at early ages in relation to curing regimes.

Concrete testing methods: appraisal of testing methods, development of new procedures, including non-destructive methods, e.g., ultrasonics.

Fibre reinforcement: the use of fibres to advantage in reinforced concrete.

NEW ZEALAND DAIRY RESEARCH INSTITUTE

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: DAISEARCH Palmerston North
TELEPHONE: 74 129 Palmerston North

DIRECTOR: W. A. McGillivray, CBE, JP, MSc, PhD *NZ*, DSc *Massey*, FRSNZ, FNZIC.

ASSISTANT DIRECTOR: P. S. Robertson, MSc *NZ*, PhD *Rdg*, FNZIC.

Fundamental Research: R. C. Lawrence, BSc(Hons), PhD *Massey*, DipEd, FNZIC.

Applied Research: W. B. Sanderson, BAgrSc, PhD *Wis*.

STAFF: 63 scientists, 64 science technicians, and 35 supporting staff.

The New Zealand Dairy Research Institute is the principal research organisation serving the manufacturing side of the New Zealand dairy industry. Its research programme includes investigating methods for the improvement of traditional dairy products such as butter, cheese, milk powder, and casein to satisfy continuous demands for improved quality; mechanisation of manufacturing processes; methods for decreasing manufacturing costs and for conserving energy within the industry; and the development of new dairy products and new uses for conventional products. Currently emphasis is placed on the maximum recovery of all milk solids and their conversion to usable foods or food additives.

Most of the work of the Institute falls into one of two broad categories: applied investigations on process and product development of new products, variations of traditional products and new uses for existing products; and a supporting category of fundamental research designed to increase the knowledge of the basic components of milk and the changes that occur during the processing of milk into dairy products.

Activities

Cheese: manufacture of non-Cheddar types of cheese, together with a continuing programme on mechanising the manufacture of Cheddar and non-Cheddar varieties.

Butter and milkfat: development of the solvent crystallisation process for the manufacture of spreadable butter and other specialty milkfat products; production of non-standard butters and other products for use in the bakery and confectionery trades.

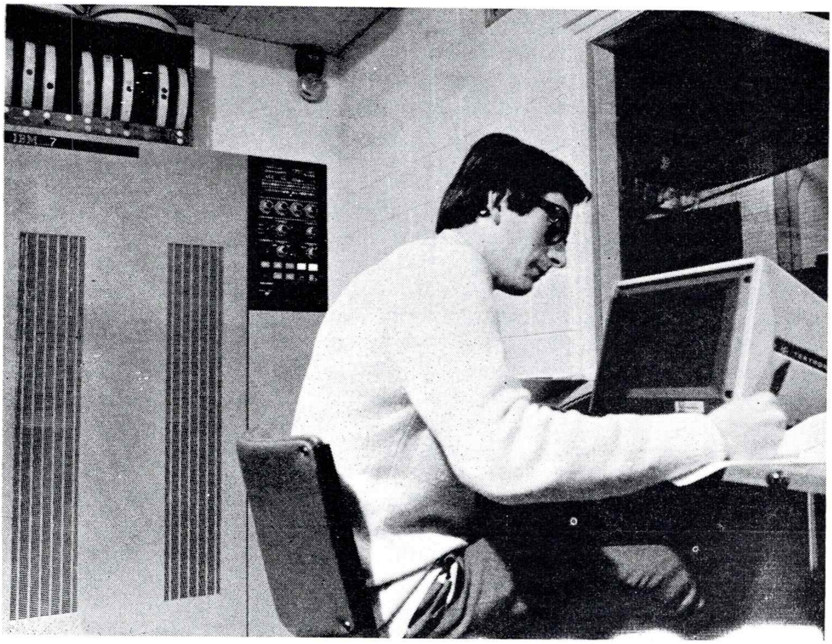
Milk powder: development of new milk powder products, particularly fat-containing powders such as "instant" whole milk powders and baby foods, assistance to dairy companies to establish commercial manufacture of these products; improving production and quality control of milk powders by automatic computerised control of evaporators and spray-drier plants.

Milk protein: functional and nutritional properties of the wide range of milk protein products now available; nature of milk proteins and their interactions during processing.

Effluent disposal: a mobile laboratory is being used to monitor effluent from dairy factories and to assist companies in minimising effluent disposal problems. Particular attention is being devoted to mass balances in dairy processing operations, in order to maximise product returns and minimise effluent. Assistance is being given to companies to improve the efficiency of spray irrigation systems, and research has commenced on alternative systems of effluent disposal.

Buildings and equipment: continued assistance is provided by the Engineering Services Section in areas of building construction and design, ventilation, energy conservation and fuel economy. This Section is also called on in a consultancy capacity to advise on the selection, commissioning and test acceptance of new equipment in dairy companies.

Liaison and information: a wide variety of technical literature, books, and publications is made available to the food industry through the Institute library. The Institute issues a comprehensive annual report, publishes the *New Zealand Journal of Dairy Science and Technology*, and produces proceedings of specialist conferences and symposia.



Attempts to improve quality control of milk powders include computerised control of the spray-drier and evaporator plants.

NEW ZEALAND FERTILISER MANUFACTURERS' RESEARCH ASSOCIATION (Inc.)

61 Otara Road, Otara, Auckland
POSTAL ADDRESS: P.O. Box 23-637, Hunters Corner
TELEPHONE: POP 47 184 Auckland

DIRECTOR: J. Rogers, MSc, PhD *Cantab,* FNZIC, MAIME, MAIMM.
Chief Chemist: P. J. Gallaher, BSc, FNZIC.
Agronomy: F. B. Muller, MS *RI.*
Physical Chemistry: M. S. White, MSc, PhD *Tas.,* MNZIC.
Chemical Engineering: D. L. Thomas, BSc(Hons), CE, MIChE.
Librarian: Mrs R. H. Van Ee, NZLA Cert.

STAFF: 11 scientists, 8 science technicians and 4 supporting staff.

The primary function of the Association is to undertake research of importance to the economic operation and future planning of the fertiliser industry. About seventy percent of the research effort is devoted to fertiliser production and the rest to fertiliser use. Progress reports are distributed to members quarterly. Services to members include specialist advisory and analytical services, particularly in the field of herbage analysis, a monthly newsletter of technical information, liaison with other research and technical bodies, and organisation of regular research symposia and technical conferences.

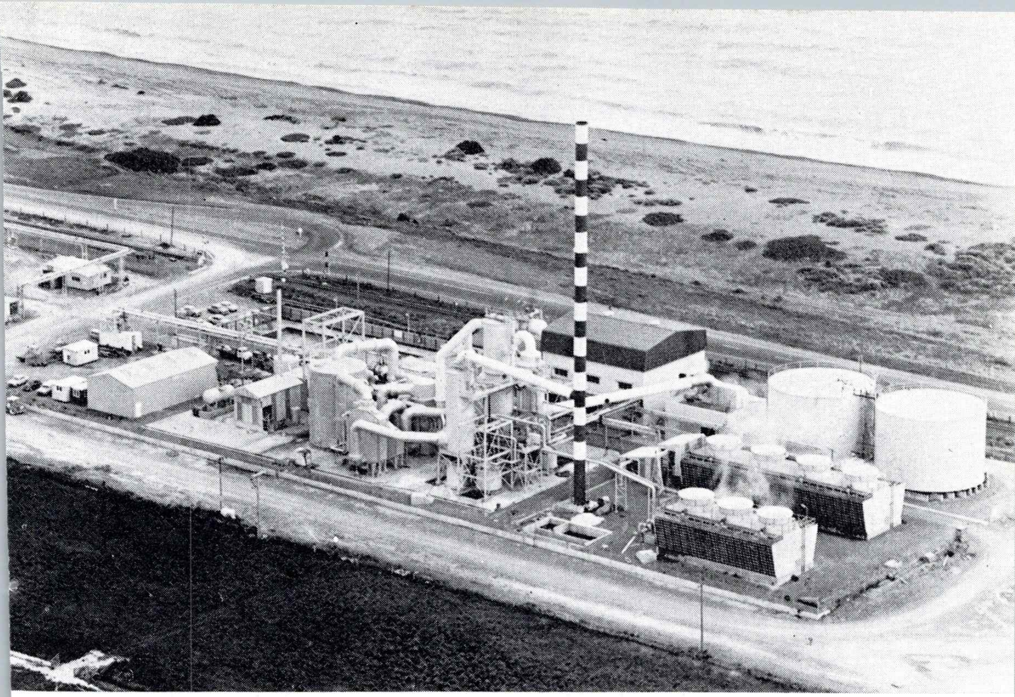
Current Projects

Research on the gases, solids, and liquids produced during the manufacture of single superphosphate from blends of 50 percent and more of Christmas Island "A" phosphate with Nauru and Ocean Island phosphate rocks was the subject of an international research symposium held in October 1976. This was the source of ideas for further laboratory research and tests in the works of member companies.

Considerable attention has been given to improving the quality of superphosphate granules. This has involved studies of the granulation and screening operations. Correlation of this information, with observations of practice in an Australian works using higher recycle ratios, resulted in an analysis which allows prediction of the size range of granules which will be produced at any given screen area and recycle rate. High recycle gave a product free from dust.

A study of the influence of additives such as limestone and serpentine on the physical (strength and porosity) and chemical (solubility in water, 2 percent citric acid and neutral ammonium citrate) properties of superphosphate granules showed that limestone addition increased the porosity and reduced the strength of the granules and the solubility of the phosphorus in them. A magnesium phosphate was identified in the serpentine mixtures.

The sizes of potassium chloride and superphosphate particles were shown to be important factors influencing the incorporation of the potassium into superphosphate granules. Small feed size and large product size gave best incorporation. Laboratory tests were developed to simulate the segregation effects which are observed in works storage piles.



New Zealand's biggest sulphuric acid plant, recently opened, has double absorption units designed to reduce sulphur dioxide emissions to a fraction of 1 percent of the sulphur burnt. Sulphuric acid is used in the manufacture of superphosphate. *Photo: East Coast Fertiliser Co. Ltd.*

Agronomic studies of the effectiveness of water-insoluble iron and aluminium fluorophosphates identified in superphosphate made from Christmas Island "A" phosphate rock were made in pot trials with material synthesised from the constituent elements and phosphoric acid using white clover as test plants. These components are soluble in neutral ammonium citrate. Long-term field trial study of the influence of superphosphate and other phosphates on pasture production during winter was begun again after a break of some years. The superphosphate treatment yield was 50 percent greater than control.

The effects of fluoride emissions on vegetation around two fertiliser works was studied using pine trees as indicator plants. Samples from concentric rings of *Pinus radiata* trees round the fluoride scrubber stock were used to measure the phosphate and fluoride content of the needles. No damage was observed after 12 months exposure at the works boundary. Some samples near the source of fluoride emission showed high fluoride content, although there was no damage to the tree. Phosphate rock and other dusts containing fluoride from sources such as superphosphate and the reaction of fluosilicic acid with limestone were the chief sources of fluoride identified.

SITE CONDITIONS: Lat: 36° 57′ S. Long: 174° 52′ E. Alt: 12 m.

Soil types: Papatoetoe and Flat bush silt loams—brown granular and meadow soils derived from volcanic ash.

Rainfall: 1220 mm per annum on 173 days, fairly even distribution, occasional dry spells in summer.

Temperature: Mean daily maximum 18.7°C; mean minimum 10°C. Days with ground frost: 40.

RESEARCH INSTITUTE OF LAUNDERERS, DRYCLEANERS, AND DYERS (Inc.)

DSIR No. 2 Building, Gracefield, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: RILDAD Lower Hutt TELEPHONE: 666 919 Wellington

DIRECTOR: N. S. Whittall, MSc.

STAFF: 4 scientific and 1 supporting staff.

The Institute acts as an advisory body to commercial laundry and drycleaning firms and also to Hospital Board laundries in respect of processes, utilisation of machines and work study and planning. It also provides a comprehensive textile testing service for its members and also to firms involved in the textile and clothing trade. With the development and changes in the textile industry, this latter service represents an increasing and valuable service to all members. The Institute arranges a number of technical conferences through the year for the various member groups. It publishes regular reports on overseas research and also on problems and developments as they affect the local industries. It carries out approximately 1500 laboratory investigations annually into cause of damage to garments and fabrics and where necessary takes action to ensure that such problems can be remedied.

Main Investigations

In recent years there has been a significant trend in both the laundry and drycleaning industries from a labour intensive to a capital machinery intensive industry. This has led to larger and more expensive machines. Such machines are high energy users. The Institute has initiated a research programme with a view to reduce energy consumption in the process and finishing departments and a comprehensive research programme, both in the laboratory and in plants, is in progress. In the textile field, laboratory work is constantly being carried out to determine the suitability of fabrics for specific purposes. For example, all fabrics used by Hospital Boards, protective clothing in industry, hotel linen, etc, are tested to a variety of tests to ensure that they meet specific requirements. Commercial furnishing fabrics are submitted to extended weathering and cleaning tests to evaluate the effect of sunlight, fumes, etc.

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (Inc.)

Corner of Dairy Farm and Poultry Farm Roads, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: LASRA Palmerston North TELEPHONE: 82 108 Palmerston North

DIRECTOR: G. W. Vivian, MSc, PhD *Leeds*, MNZIC.

STAFF: 6 scientists, 8 science technicians, and 3 supporting staff.

The Association is the central research organisation of the fellmongering, hide and skin curing, tanning and footwear manufacturing industries. Close liaison is maintained with Technical Advisory Committees of Association members in planning and assessing research programmes.

The Association disseminates results of overseas research in regular reports; tests and advises on the suitability of all types of materials, adhesives, and components for footwear manufacture and reports on approximately 500 consumer footwear complaints annually.

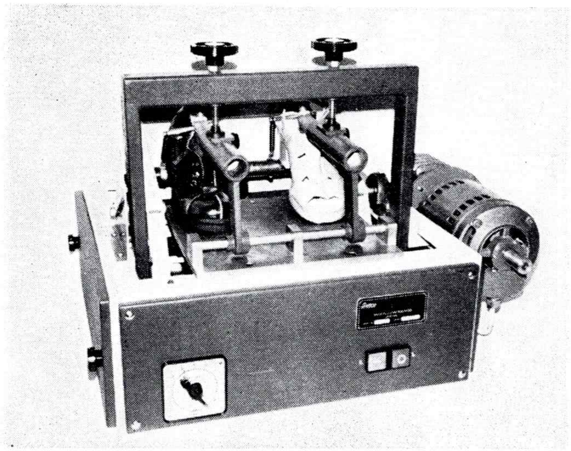
Current Projects

Hides and calfskins: the effect of breed, husbandry, and ectoparasites on raw stock and leather properties; short-term preservation.

Sheepskins and lambskins: heating in paint stacks, influence of additives in paint, re-use of lime liquors; influence of liming and bating processes on pelt grain quality; drum-curing woolskins; packaging pelts on pallets.

Leather: rapid wet blue processing; aqueous degreasing of woolskins; antioxidants in vegetable tanned leather; woolskin washability and wool lustre; evaluation of pigment binders; testing for perspiration resistance; removal of sulphide and chromium from effluents.

Footwear: abrasion tester evaluation; laces survey; shoe room treatments; qualities in leather required by footwear manufacturers.



These shoes were meant for walking, and that's what they are made to do on this flexing machine used at the Leather and Shoe Research Association for testing footwear under standardised conditions.

Significant Investigations

Hides and skins: Hides from exotic and conventional beef breeds supplied by the Ruakura Animal Research Station yielded footwear upper leather with satisfactory physical and aesthetic properties. The Simmental, South Devon, and Pie Rouge breeds have heavy hides essential for some types of leather.

Fellmongering woolskins: Fellmongering is the process of applying a solution of sodium sulphide thickened with hydrated lime (the paint) to the flesh side of washed and hydroed skins which are held overnight before wool removal (slipe wool). During the holding period, the paint penetrates to the wool roots; the chemical reaction of wool loosening is exothermic, and the heat generated can damage the pelt. The temperature of the skin when painted and the holding conditions including height of painted skin stacks have been examined to determine their relation to temperature rise. The results have been used to advise conditions for fellmongering that do not lead to pelt damage.

Wet blue processing: Hides are now being chrome tanned (wet blue) for export using a process time of 44 hours. The tanning industry has requested LASRA give priority to developing a 24 hour process. Initial investigations have given promising results, but opening up the fibre structure in the 11 hours unhairing and liming process is the main problem; this is essential for the production of good quality leather. This project includes examination of re-using sulphide-bearing unhairing liquors to reduce effluent treatment.

Children's footwear: LASRA is cooperating with the Consumers' Institute in a wear trial of children's shoes made in New Zealand. The shoes were inspected new, after 8 weeks' wear, and after the completion of the 16 week wear trial. All brands performed satisfactorily except for the laces. A survey of laces is now being carried out and a specification for them will be set up.

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION

POSTAL ADDRESS: P.O. Box 147, Rotorua

DIRECTOR: J. J. K. Spiers, BSc, MF *Brit. Columbia.*

The Association, incorporated in 1974, promotes, co-ordinates, supervises, and conducts research and scientific work in connection with the logging industry. Logging is defined by the Association as the industry engaged in harvesting trees, i.e., felling, extracting from the forest, semi-processing, and transporting wood to ship-side or to a place for processing. This definition includes all ancillary and extension services.

Activities

The initial research programme concentrates on short-term, high-impact projects such as development of costing systems for logging and transport contractors; evaluation of equipment like power saws, tree shears, and safety helmets; and investigation of the cost and effectiveness of various log segregation and preparation practices.

Proposed longer term research includes identification of existing and expected operating conditions, both topographic and tree crop, during the forthcoming rotation (e.g., 30-year) period; completion of a topographic typing of existing forest and of further areas to be afforested and requiring logging during the coming 30-year period.

As well as undertaking its own research programme, the Association acts as an information bureau and collects, collates, and disseminates New Zealand and overseas research findings. A library will be established to assist in this activity.

The Association plans to become a fee-paying member of certain overseas research organisations to receive research reports which would otherwise by unavailable in New Zealand and to use whatever consultancy services these organisations provide.

MEAT INDUSTRY RESEARCH INSTITUTE OF N.Z. (Inc.)

East Street, Claudelands, Hamilton
POSTAL ADDRESS: P.O. Box 617, Hamilton
TELEGRAMS: MIRINZ Hamilton TELEPHONE: 56 159 Hamilton

DIRECTOR: C. L. Davey, MSc, PhD *Cantab,* FNZIC.
ASSISTANT DIRECTOR: A. K. Fleming, BE(Chem), DrIng (Norway), MNZIE.
Bioscience: C. L. Davey, MSc, PhD *Cantab,* FNZIC.
Biotechnology: P. M. Nottingham, MSc, PhD *Aberd,* MNZIC, FIFST.
Engineering: D. P. Haughey, MEChem, PhD *Edin,* CEng, AMIChemE.
Administration: J. van Harskamp, ACA.

STAFF: 34 scientists, 48 science technicians, and 16 supporting staff.

The Institute is the principal research organisation serving the New Zealand meat industry. Its work is directed towards promoting and undertaking research and development in all matters concerning meat, meat by-products, and their processing, and implementing results of this work in the New Zealand meat industry.

The meat industry is New Zealand's greatest earner of overseas exchange, and achieves this mainly through the export of frozen meat. The scientific effort of MIRINZ has reflected this fact and emphasised the critical nature of refrigeration and its effect on product quality. The toughening effect of chilling hot carcasses has received particular attention, and recent research in this field has culminated in the development of the accelerated conditioning process.

MIRINZ is studying methods of humane slaughter, since EEC regulations will shortly require that lambs be rendered insensible to pain before they are killed. An efficient electrical stunning gun has been developed and is now being manufactured by a New Zealand company.

Current Projects

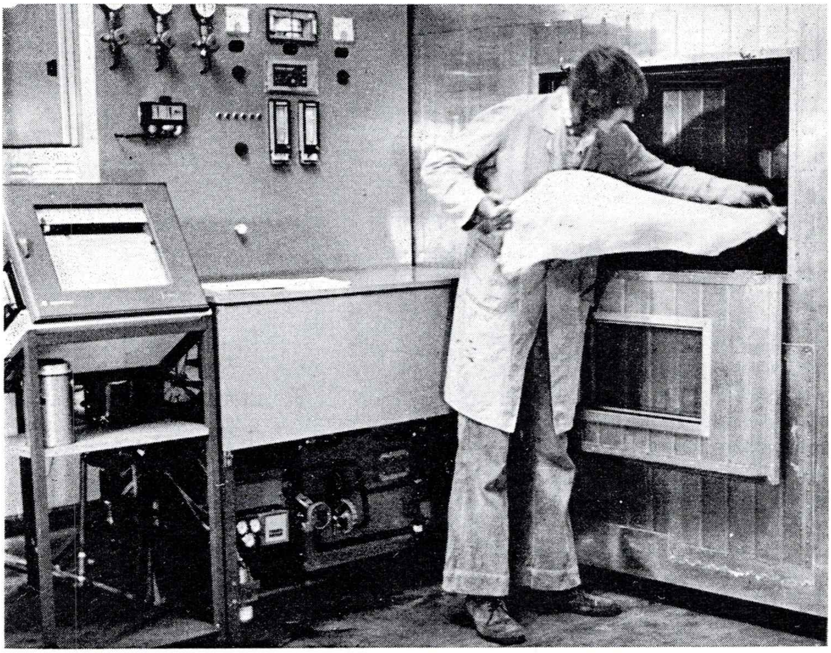
Muscle biology: muscle structure and function; changes in muscle during the onset of rigor mortis and during aging; the mechanism of rapid conditioning through electrical stimulation; characterisation of elastic proteins in muscle; molecular organisation in structural aggregates important to muscular contraction; histology and muscle growth.

Meat and meat products: accelerated conditioning of lamb; aging of lamb after accelerated conditioning; temperature coefficient of meat aging; accelerated conditioning in beef; waste meat recovery and refabrication; mutton-based small goods through meat flaking.

Meat quality: meat quality from pasture-fed and maize silage-fed beef cattle; comparison of chilled lamb with the traditionally thawed lamb; palatability of meat from various beef breeds.

Meat by-products: preservation of blood; rendering; new product development; recovery of meat protein from bones.

Microbiology: physiology of meat-spoilage organisms; biochemistry and microbiology of the spoilage process; staphylococci in meat; packaging and the microflora of chilled meat; competitive growth of pathogenic and saprophytic organisms; microbiological quality control, hygiene, and



Because chilling causes toughening of meat, studies have been made of different chilling conditions needed to produce an acceptably tender product for the consumer.

sanitation; electron microscopy as an aid to medical and veterinary diagnosis.

Pollution abatement: recovery of protein from wastes by chemical treatment and air flotation; in-plant abatement; water conservation and re-use; treatment of fellmongery wastes; solids waste treatment; production of single-cell protein; aerobic and anaerobic biological treatment of meat wastes; pea fat reduction.

Industrial services: properties of packaging films; carton freezer trials; evaluation of the South Island meat loaders and transport system for frozen lamb; analytical services; calibration of industrial instruments; optimal capital investment for labour replacement; electrical stunning.

Refrigeration and energy: model studies of chilling and freezing using a variable-temperature wind tunnel; mathematical models for heat transfer and process control during meat transportation; refrigeration and energy studies; evaluation of automatic carcass freezers and model study of improved methods of air distribution.

By-product processing: viscera cutting; pneumatic handling of offal; fluidised-bed drying of blood; protein concentration by ultrafiltration; survey of rendering plant; heparin recovery and assay.

Instrumentation and control: humidity measurement; air velocity measurement; radio telemetry; analogue control; computer control; engineering aspects of electrical stimulation; measurement of carcass freezing times.

NEW ZEALAND POTTERY AND CERAMICS RESEARCH ASSOCIATION (Inc.)

DSIR No. 2 Building, Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: PACRA, Physical, Lower Hutt TELEPHONE: 666 919 Wellington

DIRECTOR: H. J. Percival, MSc(Hons), PhD *Well.*, MNZIC.
Ceramic Advisory Testing Service: Mrs Z. Demchenko, DipIngChem *Kharkov*, MNZIC.

STAFF: 5 scientists, 4 technicians, and 2 supporting staff.

The Association engages in research work relevant to current interests of the New Zealand ceramics industry and provides a technical advice, information, and testing service for the industry. Research interests can be divided into two broad categories: investigations related to the improvement of the manufacturing processes, and investigations aimed at improving the use of the final product.

Current Projects

Slip research: Studies of correlations between physical properties of slips and their corresponding plastic bodies, and between the physical properties of slips and their chemical nature continues. It is intended to determine, given particular raw materials, what the optimum combination of slip formulation parameters is to give the most suitable plastic body; and, having decided on the formulation, what measurements are best made to ensure control at the optimum.

Masonry: The programme of dynamic load testing of brick veneer panels on timber frames continues. The aim is to demonstrate the seismic capacity of reinforced and unreinforced veneers under face loading. Different designs are being tested (e.g. variation in stud spacing).

Pipe studies: Changes in the methods of drying and firing of pipes are being examined, changes aimed at improving dimensional tolerances and increasing the pipe length without increasing the pipe weight. Thinner-walled pipes are necessary, and therefore practical methods for giving the required increased strength to the pipe material are being investigated. An additional project involves work on reducing the permeability to air of clay pipes.

Whiteware product studies: The successful development of crack growth and fracture toughness measurement techniques at PACRA, and of sample preparation for such measurements, has led to their introduction into a project on whiteware products (porcelain insulators, sanitaryware and tableware). This new project involves the determination of the crack propagation parameters of the finished product materials to assess their characteristics under mechanical stress situations. Dynamic load testing of some of these products with the structure testing facility currently used for the masonry project is a likely addition to the programme.

WOOL RESEARCH ORGANISATION OF NEW ZEALAND (Inc.)

Springs Road, Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: WRONZ Christchurch TELEPHONE: 8009 Halswell

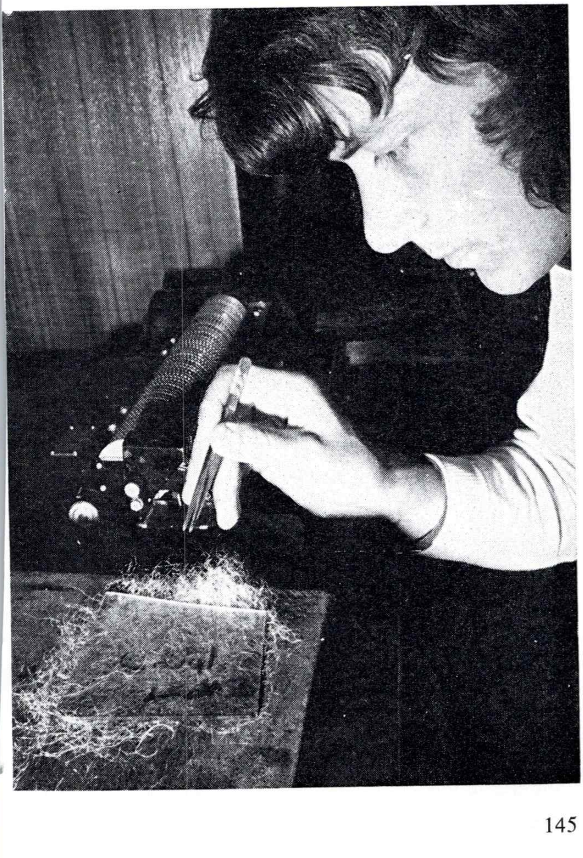
DIRECTOR: N. F. Roberts, MSc, FInstP, FTI.
SECRETARY: C. P. McEvedy, BCom, FCA.

Textile Technology: D. A. Ross, MAgrSc, PhD *Leeds.*
Wool Science: W. S. Simpson, MSc, PhD *Leeds,* FNZIC.
Scouring, Bleaching, and Slipe Wool: R. G. Stewart, MSc, CChem, MRIC.
Measurement and Marketing: A. R. Edmunds, MSc, PhD *Leeds,* FNZEI.
Engineering Services: A. Barker, CEng, MIMechE, MNZIE.
Scientific Services: L. F. Story, BSc, PhD *London,* CChem, MRIC.

STAFF: 29 scientific, and 55 supporting staff.

The Organisation undertakes research on all matters relating to the utilisation of New Zealand wool, including chemical and physical properties, marketing, scouring, processing and end use performance.

Current Projects
Textile technology: self-twist spinning of crossbred wools, including the development of an attachment to the Repco machine for making fancy



Fibre length of wool affects the properties and end uses. Here a knitting student is learning how to measure the length of fibres.

slub yarns; development of various types of crossbred knitwear and high-pile blankets; uses of variegated yarns in blankets, knitwear, and carpets.

The efficiency of tufting carpets from wool yarns is being studied. The performance of carpets in relation to wear and appearance has high priority. The WRONZ Carpet Wear Simulator is proving to be very satisfactory for evaluating the wear performance. Methods of setting yarns are being studied for improved appearance retention in carpets. WRONZ is now assisting in the specification of contract carpets.

High-bulk yarns are now being made by artificial crimping. An aerodynamic method of removing vegetable matter from wool for semi-worsted processing is being developed. Relationships between processing performance and characteristics of wools are under study in the pilot plant. Practical courses in yarn manufacture are being organised in conjunction with the Textile Industry Training Board.

Wool science: Static generation on carpets can now be satisfactorily inhibited and commercial applications are in hand, particularly for contract carpeting. New outlets for flameproof wool products, e.g., protective clothing, continue to develop and more effective washfast treatments follow from the study of exhaustion and fixation of metal complexes. An evaluation of the commercial potential of polymer-treated wool felt for removing metal ions from water is in hand. The basic surface properties of wool fibres are being studied in relation to staining, soiling, and cleaning of carpets.

Progress is being made in defining the primary chemical events which occur during the photodegradation of wool, by using electron spin resonance techniques. The cross-dyeing of wool with the assistance of tannic acid, cationic compounds, and chlorination is being studied. Biological processes of wool growth are being studied.

Scouring, bleaching, and slipe wool: The WRONZ Comprehensive Scouring System can be operated at a very low flowdown, and treatments to de-water the more concentrated effluent by ultrafilltration, and de-sludging centrifuges are being examined. Energy usage and conservation in the industry are being examined with a view to making all possible economies; recovery of heat from dryers has considerable potential. Weighfeeding is being examined at a works as a means of improving uniformity of scouring and drying. A three-months course in Wool Technology at Lincoln College is being staffed by WRONZ personnel.

Wool measurement and marketing: Sale by sample is now developing rapidly following demonstrations of the reliability of grab-sampling techniques—there is some problem with pack contamination during sampling and this is being examined. A standard test method for measuring the colour of scoured wool for specification purposes is being developed. Slipe grading—improved uniformity and consistency are the results of surveys of slipe wools throughout the industry. Methods of sampling scoured wool are being re-checked, and the detection of insufficiently dried wool in bales is being instrumented.

Scientific services: testing and investigations for industry; synthetic woolpacks; training course in testing.

RECENTLY PUBLISHED RESEARCH

Citations are arranged by Division, in alphabetical order of first Divisional author

ANTARCTIC DIVISION

(Antarctic Division co-ordinates and implements all New Zealand Antarctic activities. Publications listed below are those of all organisations taking part, including other divisions of DSIR, other government departments, the universities, and other research bodies.)

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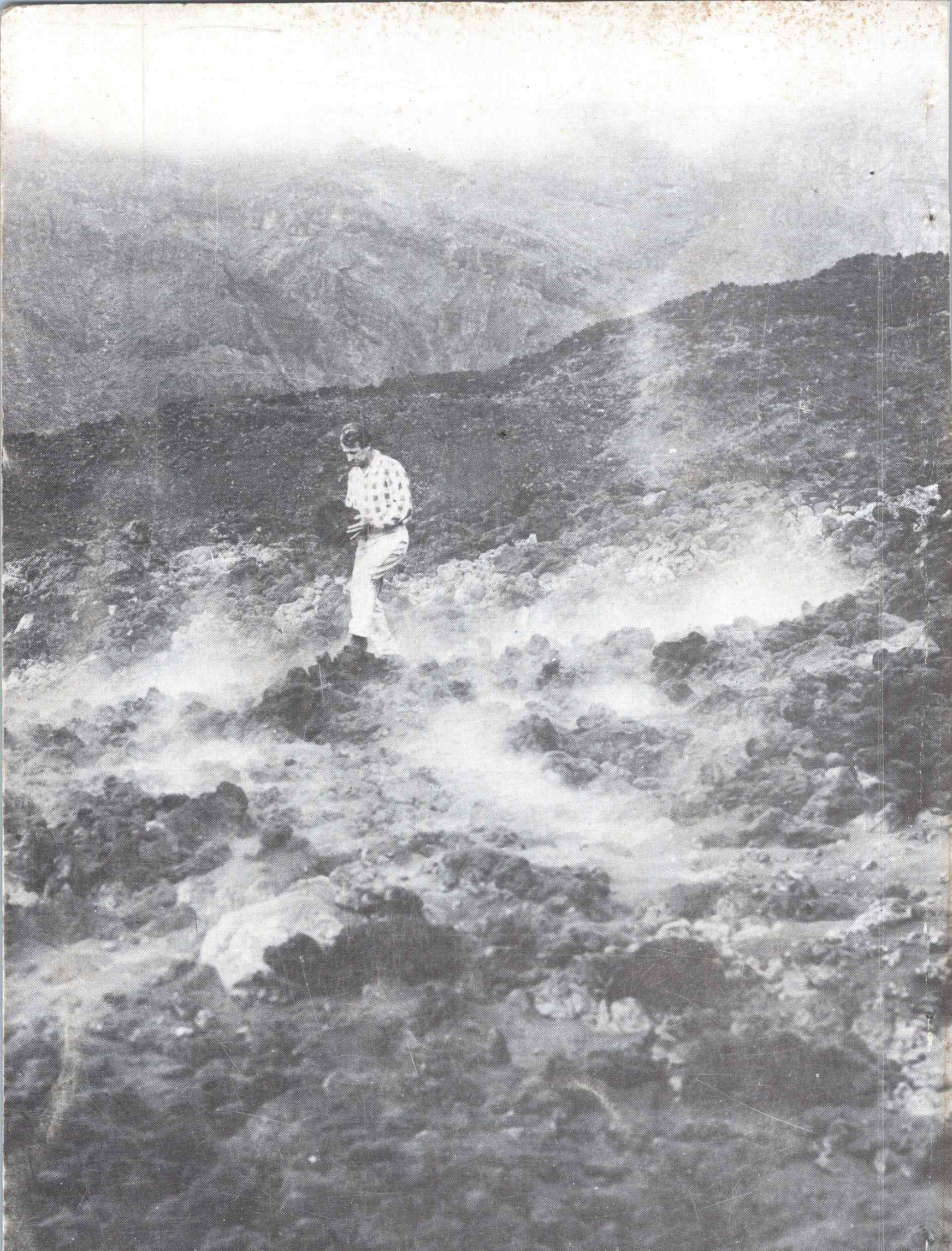

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